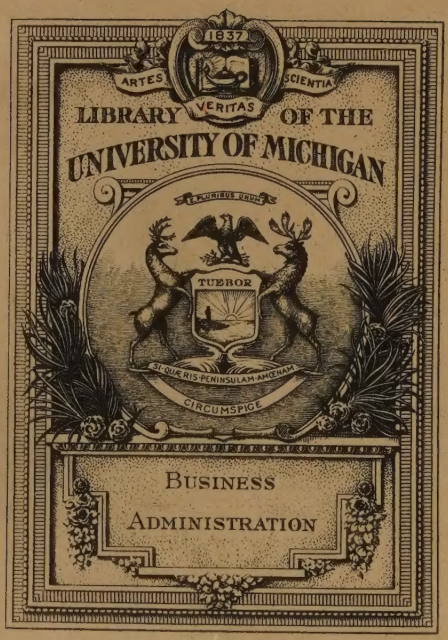
APPLIED METHODS OF SCIENTIFIC MANAGEMENT

FREDERIC A. PARKHURST


1837
ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
SI QUÆRIS PENINSULAM AMŒNAM
CIRCUMSPICE
BUSINESS
ADMINISTRATION

BUS. ADM.
LIBRARY
T
55.9
.P24
191

WORKS OF F. A. PARKHURST

PUBLISHED BY

JOHN WILEY & SONS, Inc.

Applied Methods of Scientific Management.

Second Edition. xii+337 pages. 6 by 9. Illustrated. Cloth, $3.00 net.

The Predetermination of True Costs and Relatively True Selling Prices.

104 pages. 6 by 9. Illustrated. Cloth $1.25 net.

Symbols.

The system of symbols adopted in this book has been used in various plants for many years. They constitute a language in themselves. A few characters, suggestive to a marked degree, replace from six to many times six the number of letters that would ordinarily be required to describe the same thing, or combination of things in the usual words. The symbols in this book can be amplified to an unlimited extent to meet any ultimate demands. vi+165 pages. 6 by 9. Cloth, $2.00 net.

APPLIED METHODS

OF

SCIENTIFIC MANAGEMENT

BY

FREDERIC A. PARKHURST, M.E.

ORGANIZING ENGINEER, ASSOC. A.S.M.E.

Author of

"PREDETERMINATION OF PRICES"

SECOND EDITION

TOTAL ISSUE, FIVE THOUSAND

NEW YORK

JOHN WILEY & SONS, INC.

LONDON: CHAPMAN & HALL, LIMITED

COPYRIGHT, 1911
BY
THE TECHNICAL LITERATURE CO.

COPYRIGHT, 1912, 1917
BY
FREDERIC A. PARKHURST

12/21

PRESS OF
BRAUNWORTH & CO.
BOOK MANUFACTURERS
BROOKLYN, N. Y.

TO

My Esteemed Father

HON. WALTER S. GLIDDEN

Bus. Adm.
W2hr
6-3-26
13311

PREFACE TO FIRST EDITION

THIS work is an amplification of the Author's article, "Applied Methods of Scientific Management," which appeared in *Industrial Engineering* during the last nine months of the year 1911. It has seemed advisable to publish the serial in book form because of its success. An appendix contains much new matter which was not included in the original publication for want of space. The instructions and forms show substantially the medium employed to incorporate the principles of the Science of Management into an efficient organization suitable for a plant under the specific conditions illustrated.

The author believes in adapting all details to meet each existing condition as found. He believes in developing existing plant to its highest possible efficiency before making large outlays for extensive alterations or additions. This same principle he applies to the placing, development and advancement of each individual member in the works organization. The obligations of the employer and employee to each other are not overlooked. Their interests are mutual and the principles involved tend toward the promotion of their combined progress and prosperity.

The mechanical issue of each problem can be fully recorded; but the psychological side of the subject cannot be predetermined nor authentically inscribed. The human element is at once the most important factor, and the greatest variable in the problem which the organizer has to solve, and his success depends largely upon his ability to recognize and handle this phase of the proposition.

Theories and generalities have been avoided throughout these pages, and the subject has been treated from the practical point of view, intensified by many years of experience along these lines. That this work may fill a long felt need of the business men in charge of affairs and of all students of the Science of Management is the earnest hope of

THE AUTHOR.

PREFACE TO SECOND EDITION (1917)

THE first and second editions of this book are identical up to and including page 320. In a new chapter following the Appendix the reader will find some interesting facts relating to the Author's methods at "Ferracute" during the last six years. The new chapter also discusses the favorable change of opinion throughout the industrial world since 1912 in regard to the science of management. Copies of certain letters written by officials of the Ferracute Machine Co., also several illustrations, will prove interesting to the reader as indicating in condensed form how the methods herein described are helping to vindicate this new Science.

THE AUTHOR.

TABLE OF CONTENTS

SECTION I

CHAPTER I

PAGE

The Organization of the Ferracute Machine Co.; a Plant Operating under Scientific Management 1
1-A. The preliminary investigation 4
1-B. The form of organization 8
1-C. The organization record 11

CHAPTER II

2-A. The functions of the sales department and counting room 13
2-B. The functions of the engineering room 27
2-C. The functions of the drafting room 29

CHAPTER III

3-A. The planning department 37
3-B. Duties of the superintendent 40
3-C. Functions of the planning department 43
3-D. The production clerk 47
3-E. The shop engineer 48
3-F. The stores clerk 49
3-G. The cost clerk 50
3-H. The route clerk 50
3-I. The order-of-work clerk 52
3-J. The shipping clerk 53
3-K. The receiving clerk 53
3-L. The time clerk 54
3-M. The schedule clerk 55
3-N. The factory mail system 56
3-O. The time boy 58
3-P. The inspector 59
3-Q. The stores keeper 61
3-R. The move material boss 62

CHAPTER IV

PAGE

Systematic Routing a Necessity 64
4-A. The routing of work through the shops 65
4-B. Symbols 70
4-C. The functions of the material boss 78
4-D. The functions of the order-of-work clerk 80
4-E. Gang bosses 85
4-F. Functions of the speed boss 87

CHAPTER V

Importance of a Modern System of Stores 89
5-A. The creation of a stores department 92
5-B. The stores ledger, or perpetual inventory 98
5-C. The registering of time consumption 105
5-D. The combined cost and route sheet 110

CHAPTER VI

6-A. The standardization of methods and tools 115
6-B. The development of a manufacturing system 132
6-C. The handling of erection work 135

CHAPTER VII

Preliminary work necessary before attempting to make time studies 143
7-A. Introduction of time studies 147
7-B. Analysis of time studies and the development of instruction cards 157
7-C. Discussion of piece work, premium, bonus, differential piece work and differential bonus systems of payment 166
7-D. Method used by the author to compute differential bonus 175

CHAPTER VIII

8-A. A concrete example of the course an order takes from its possible existence as an inquiry to its shipment complete 181
8-B. A comparison of some of the results under old and new methods 186
8-C. Closure 195

APPENDIX

PAGE

I. Organization record of the Ferracute Machine Company 199
II. Duties of the vice president and assistant manager 200
III. Superintendent's instructions 202
IV. Shop rules of Ferracute Machine Company 206
V. Grading of apprentices 211
VI. Instructions for die engineers 211
VII. Drafting room instructions 215
VIII. Instructions for drawing and sketch indexes 223
IX. Duties of the chief clerk 226
X. Planning department. Production clerk's instructions 231
XI. Planning department monthly report 233
XII. Symbol groups 240
XIII. Manufacturing numbers 242
XIV. Anticipating requirements 243
XV. Follow up methods. Order-of-work clerk 246
XVI. Movement of batches in installments 249
XVII. Route rack signals 249
XVIII. Stores clerk 250
XIX. Instructions for the care and inventory of scrap metals 253
XX. Chief cost clerk's instructions 256
XXI. Time keeper's instructions 263
XXII. Decimal system of time keeping 267
XXIII. Time clock 268
XXIV. Schedule clerk 270
XXV. Factory mail system 279
XXVI. Inspector 281
XXVII. Stores keeper 285
XXVIII. Tool foreman's instructions 287
XXIX. General instructions regarding tool requirements 293
XXX. Instructions for the care and storage of tools 295
XXXI. Shop drawing boy's instructions 296
XXXII. Duties of the night watchman 299
XXXIII. Janitor's instructions 301
XXXIV. Duties of the crane boss 304
XXXV. Instructions pertaining to general orders 306
XXXVI. Old, broken or replaced parts returned 310
XXXVII. Purchase orders 311
XXXVIII. Patterns and casting purchase orders 313
XXXIX. Brief description of each form, giving figures or plates and page reference 314
Six years after (Feb., 1917) 321

ILLUSTRATIONS

PAGE

Alteration memorandum, Fig. 48 320
Bonus notice, special, Fig. 51 329
Bonus notice, special, Fig. 52 330
Bonus notice, special, Fig. 53 330
Bonus notice, special, Fig. 54 331
Bonus notice, special, Fig. 55 331
Bonus pay slip, Fig. 44 258
Bristol recording horse power meter, Fig. 28 155
Casting purchase order, Plate III ..... *at back of book*
Casting receipt, Fig. 45 276
Condemnation report, Fig. 8 61
Day work diagram, Fig. 31 172
Department order, Fig. 47 316
Detail drawing, Fig. 4 30
Drawing index by customer, Fig. 41 224
Drawing index by number, Fig. 39 223
Drawing index by subject, Fig. 40 224
Efficiency record chart, Fig. 50 328
Erection chart, Fig. 23 137
Erection floor, section of, Fig. 24 139
Erection floor, section of, Fig. 25 140
Gantt bonus diagram, Fig. 34 173
General order, Plate IV ..... *at back of book*
Horse power chart, Fig. 29 156
Instruction card, Fig. 30 158
Inventory sheet, Plate IX ..... *at back of book*
Letterhead, reproduction of, Fig. 49 327
Material card, Fig. 19 103
Material list, Fig. 5 35
Move material form, Fig. 12 79
Next work order, Fig. 9 62
Organization chart, Fig. 1 ..... *facing page* 8
Parkhurst differential bonus diagram, Fig. 36 176
Piece work diagram, Fig. 32 172
Planning department, controlling section, Fig. 6 45

PAGE
Planning department, statistical section, Fig. 7 46
Platform for gang bosses, Fig. 14 86
Premium work diagram, Fig. 33 172
Press record, Fig. 46 307
Press schedule, Fig. 13 81
Production and cost chart, Fig. 37 194
Purchase orders, Plate I ..... *at back of book*
Route sheet, general, Plate V ..... *at back of book*
Route rack, PlateVI ..... *at back of book*
Repair tag, Fig. 11 69
Requisition form, Fig. 2 14
Schedule, Plate II ..... *at back of book*
Schedule cost sheet, Plates VII and VIII ..... *at back of book*
Sketch index by number, Fig. 43 225
Sketch index by subject, Fig. 42 225
Solicitation record, Fig. 3 18
Stop watch and observation board, Fig. 26 148
Stores card, Fig. 17 99
Stores ledger, for 10,000 cards, Fig. 18 101
Stores room, Fig. 15 96
Stores room, Fig. 16 97
Symbol tag, Fig. 10 68
Taylor differential piece rate diagram, Fig. 35 173
Time card, job, Fig. 30 107
Tool room, maintenance section of, Fig. 21 126
Tool room, storage section of, Fig. 22 127
Time study, Fig. 27 149
Visitor's permit, Fig. 38 210

APPLIED METHODS OF SCIENTIFIC MANAGEMENT

CHAPTER I

1-A. The Preliminary Investigation
1-B. The Form of Organization
1-C. The Organization Record

Five years ago the term "Scientific Management" would have conveyed nothing to the majority of minds. To the minority it meant the highest imaginable development of a business through an exact knowledge and control of the most minute details incident to that business. To-day, the modern business man recognizes the term as synonymous with maximum efficiency. No one, however, who has not made a systematic study of the subject has any conception of its scope. Many still consider it impossible to give a practical demonstration of its value. This is just what I propose to do—show how a plant 30 or 40 per cent efficient can be put on a 90 per cent or more, efficiency basis.

Mr. Fred W. Taylor, the originator of Scientific Management, and his able associates, have described the principles in detail, and any attempt of mine to elaborate upon them would be superfluous. The principles always remain the same, but the methods employed to incorporate these principles into a practical organization must be modified or expanded to meet the requirements of specific conditions. In these pages the application of methods will be treated in detail, and illustrated by the history of them as applied

to the Ferracute Machine Co., maker of presses and dies at Bridgeton, N. J. The methods to be described are on lines parallel to those laid down by Mr. Taylor and are particularly adapted to a business employing 100 people or more.

A firm contemplating the installation of modern methods is not often prepared to assume a large expenditure for additional plant or equipment. Such was the fact at Bridgeton. The plant was built about six years ago, after the destruction by fire of the original works. It is admirably designed, the arrangement of the machinery well planned, and each machine is equipped with individual electric motor drive. There have been no radical changes made in the plant or equipment during the installation of the new methods. Excluding a few minor clerical positions, all the incumbents of the positions created by the new system of management, with one exception, are old employees educated to their new duties. The one exception was procured from out of town, after a period of more than two years, during which time each available man had been thoroughly tried out in the position. Since all results have been obtained with practically the same equipment and employees, all improvement in results must be credited to improved methods alone.

Conspicuous among the improvements in results at Bridgeton is a complete file of accurate analytical costs which makes possible the reduction of prices on a number of sizes of several different types of machines. Thus certain sizes of popular types of presses, seldom ordered and then sold at a loss, or at a minimum of profit to the company, because the competitor could market them at lower prices, are now being sold at figures which compare favorably with those for similar machines of other makes, resulting in an increased and profitable business in these lines. Other types of machines, which to-day are of heavier and improved design, are being built to sell with no proportionate increase of the selling price over that of the older

and lighter design. Combined with this, the average day wage rate has been increased about 11 per cent, and the bonus workers are earning from 20 to 60 per cent more than their day rate. The increased overhead expense, or burden due to the additional cost of installing and maintaining the system, is, of course, included in the costs referred to.

Work of this nature cannot be successfully carried on without a broad and varied experience combined with a special study of the principles involved. It is not the purpose of this book to describe a system of Scientific Management that can be installed by the novice; but it is hoped that these pages may aid the business man in locating the deficiencies of his own specific line, and induce him to adopt scientific methods in the management of his business. The adoption of scientific methods will make it possible, by reducing the cost of production, for the manufacturer to compete in the open market in the foreign centers of the world on an equal selling basis. The quality of our American output is beyond question, but the necessity of quoting a higher selling price, owing to the high rate of productive labor, has kept the volume of our exports much below its possible figure. Applied methods of scientific management balance all discrepancies in cost of productive labor by the economies of its operations.

This chapter will be divided into three parts, as follows:

1-A. Preliminary investigation, diagnosis of existing conditions, and the application of immediate relief to particularly serious troubles until the new organization is under way.

1-B. Planning of the new organization, and the making of a graphical chart of the same for the instruction of all employees from the president down, which chart shall also show what equipment is in charge of each incumbent.

1-C. Description of the organization record, which contains an exact copy of all instructions issued to each and every incumbent as per organization chart.

1-A. The Preliminary Investigation

Preparatory to taking up organization work it is necessary that the organizer be in a position of absolute authority. The firm must realize at the beginning that otherwise it would be futile to expect him to obtain maximum results, and they must reconcile themselves and their employees to this new condition from the start. An appropriation mutually agreed upon should be put at the organizer's disposal, on which he is free to draw, thus eliminating annoying delays and consultations. The amount involved need not necessarily be a large one, though how large depends on local conditions. It must be understood, and always borne in mind by all interested, that he, as well as the others, is in the employ of the firm for the purpose of creating and working in harmony to a definite end. In addition to this the organizer is an instructor, called in, as an expert in a special capacity and for a limited time, to instruct the old employees. These facts being understood, the cooperation of the officials, department heads, etc., will result in the quicker and more complete installation of the new methods, and at the same time will enable them to carry out their duties with greater ease and efficiency than was before possible. Although radical changes will often be made, and results be obtained which, based on past standards, will seem remarkable, these should not be construed as in any way reflecting on the ability or loyalty of the old employees. These men may be most industrious and may have some knowledge of improved methods, but the routine duties of each prohibit the putting of such methods into effect. This one fact alone makes it extremely necessary and desirable that work of this kind should be in charge of an expert, specially trained and free to work out the problems that will come up without being handicapped by routine work.

The report is often circulated through the office and works, previous to the organizer's arrival, that a new

man is coming to make them hustle. In point of fact the word hustle is most inappropriate. This report loses nothing by repeated telling, and by the time the organizer arrives everybody is in anything but a proper frame of mind. This condition at the start is to be deplored, and is most unnecessary. The days of relying solely upon the energy and force of any man to produce results by constant driving, are passing. The increased production per man is due to a combination of many different factors which have prepared the way to make the increase possible. The organizer aims to provide an incentive, in the form of extra remuneration, to develop and maintain a desire in each man to increase his own efficiency. He makes it possible for each man to attain his desire by removing the annoying delays incident upon lack of material, inferior tools or need of more complete instructions. The members of the firm could themselves prepare the way prior to the expert's arrival, by explaining the aim of the new régime, and the good resulting would be immeasurable.

The kind and size of the works, its equipment, the variety of its product, personnel of its employees, the attitude of the management, condition of business, volume of orders and the available capital to be expended on improved methods, all have a most important bearing on the time that will be required to properly install and get into smooth running order an adequate system of the kind to be described. A firm's decision to install a modern system of management is often delayed until some serious condition makes it imperative. The result is that the organizer's first duty should be to make a thorough preliminary investigation in the effort to determine just what the most serious troubles are, with an idea of giving immediate relief. This relief can often be given so as to materially decrease the handicap resulting from the cause, and at the same time be so applied that in connection with other methods it will be incorporated into the permanent organization.

For example, a condition commonly found is a bad congestion of work in the shops, an order list containing orders months overdue, daily stir-ups from dissatisfied customers, cancellations of orders and loss of business due to the necessity for quoting unreasonably long deliveries. A careful investigation of the list of unfinished orders, and the methods employed to order material, together with an inquiry into the process of handling the work through the shops, will often result in bringing to light one or more particularly weak links in the chain which prove responsible in a great measure for the congested condition. The fact that the shop is full of castings and other material does not in itself indicate that the shop is unable to move the work. I have one particular case in mind where this very condition existed. An inspection of the foundry orders showed that over two thousand castings were on order at the time, some of which had been on order more than a year. Investigation showed that the castings in the shop were chiefly the large and heavy ones of the finest run of foundry work. They were perfectly useless, however, without the lighter and more intricate ones, which the foundry purposely neglected to make as they were less profitable. In this particular case all foundry work had always been contracted to an independent concern. Only by " burning the wires " could the required castings finally be obtained to make possible the belated shipment of a machine.

This matter was immediately taken up, a proper casting purchase order form put in use, a purchase order schedule started, and the casting orders divided between three foundries instead of all going to one. By strenuous efforts in routing each variety of piece separately and bringing like parts through in lots, the work was moved and orders saved, whereas on the face of it the shop had already too many castings in the way. The relief given, though being almost immediate, was worked out by a definite method which remains to-day in its original form as an important

part of the present organization. The above example is one of many which may come up, and illustrates the importance of giving immediate relief wherever possible, while other details and methods are being planned and put into effect. This prompt relief need never be a makeshift but always in line with the ultimate plan of management which it is proposed to install.

Another common source of trouble is the lack of a sufficient organization with clearly defined responsibilities and duties for each incumbent of the various positions. This results in friction and misunderstandings, one man feeling that the other is treading on his toes, so to speak. The shop man feels that the man in the office is not attending to his work, that if he ordered material more promptly and made his orders more complete, work would go through a great deal more quickly. The man in the office feels that he must personally look after the details of the work of the shop and is inclined to extend his field of activity into all branches of the business. This attitude does not necessarily show a desire to usurp the other man's job, or to meddle with his affairs, but is often due to excessive zeal in trying to further the firm's best interests, and is done entirely in ignorance of the demoralizing effect which such an attitude must have. Another serious trouble resulting from the need of a proper and clearly defined organization, is found in the unfair handling of the rank and file of employees. Under a modern system this is impossible. While each man stands on a nominally equal footing with the others, his personal endeavors, ability and industry makes possible his advancement, in the class of work, earning power and promotion, independently of the others. Suggestions are solicited from the men as to improved ways or means of doing work, and are gladly paid for when it is possible to adopt them. Relationship, friendship or other possible " pull " has no influence. The " square deal " is the order of the day.

1-B. The Form of Organization

After making a thorough study of the plant geographically and of the personnel of the employees and department heads, the required organization is to be mapped out. This should be done carefully, always bearing in mind that the new type of organization is one which is radical in many ways. The determination of the duties of each person and the choosing of the incumbent for each position should be done diplomatically and with tact. Only in extreme cases should positions be permanently filled by men from outside. Each individual must of necessity be trained to his new duties, and an employee should always be given the preference. If care is taken in selecting the person for each position, he can be trained and developed into a better and more valuable man for the company, because of his experience and knowledge of that company's work.

When a certain position is not being filled satisfactorily and it seems impossible to train the incumbent, it is no indication that he is no longer valuable to the firm. In point of fact, the trouble probably is that he has been put into a position for which he is not fitted. I have known many good men at one time or another who were a detriment to the company because they were doing work for which they were not fitted, to prove invaluable when put into positions for which they were adapted. Again, I have known men of little use to be developed into efficient workmen, with a greatly increased earning power, when put under proper written instructions based upon actual stop-watch observations.

Having decided on the personnel of the organization, a chart should be made showing clearly the line of authority and the responsibility of each individual. The accompanying chart, Fig. 1, showing the organization of the Ferracute Machine Co., illustrates the method used, and an inspection of the chart will show it to be self-explanatory.

These charts are 24×36 ins., in the form of blue prints framed under glass. One is hung in a conspicuous place in the office, one in the production department, and one in each of the manufacturing departments. They are easy of access and form an efficient means of instructing all employees in the working of the new organization. The name of each incumbent appears on the chart opposite the printed title.

It will be noticed on this chart that the press shop is divided into groups of men and machines. Each group has a gang boss, who is responsible to the press shop foreman. Under the old method this entire department was in charge of one man. It is obviously impossible for one man to give proper attention to a department of 75 to 100 men. The gang bosses are so distributed that none is responsible for more than ten or twelve men. Their duties, as will be explained later on, relieve them of practically all clerical work, thus leaving them free to give strict attention to the men under them. They are considered as productive labor, and their time is distributed over the jobs on which their men have worked each day, or to jobs to which they personally have been obliged to give their time. Often a gang boss, though having ten or twelve men under him, will have his duties distributed over but part of their work and these jobs bear his time *pro rata*. The gang boss is released from even the planning of the order in which work is to be done at each machine, and he has nothing to do with material, moving of work, speeds, feeds or cuts, or methods and tools to be used.

In the organization as shown, the departments other than the press shop are all small and employ but few men, except the tool room and die shop. The tool room is run practically on a jobbing shop basis, although new work is routed to this department the same as elsewhere. The die shop is both a jobbing and manufacturing department, and its work is routed to the individual machines and men, as well as in the form of a job. Although the

die shop chart does not show it, this department has temporary gang bosses. This is a variable condition, which changes according to the class of work on which the shop happens to be employed. Sometimes there will be two or three temporary gang bosses, each in charge of a certain specific gang for a given job or class of work; and at other times the work may be of such nature that all the men will be working as journeymen, except the foremen.

The erecting floor is in charge of a gang boss under whom are several assistant gang bosses, according to the number of jobs or different kinds of work in process on the floor at one time.

Referring to the reproduction of this chart, Fig. 1, it will be seen that the planning department is the medium through which the superintendent controls the shops. All orders, designs, detail drawings, supervision of new work, etc., emanating from either the counting room or the engineering and drafting rooms, must pass through the superintendent and the planning department, before reaching the manufacturing department. The planning department is a clearing house. In the type of organization shown, the functional foremanship principle is carried out in a modified way, suited to a small works. In some cases three distinct functional positions are filled by one man. His instructions are complete and separate for each position he fills, and are made out as though they were to be issued to three different men. The third chapter of this book will deal fully with this subject of functional instruction and describe its advantages.

When the organization is laid out and charted as above described, each man's position is made perfectly clear, and he easily informs himself as to what course to take when transacting business with other departments. Each workman knows what particular gang boss he is immediately under; each gang boss knows what foreman he is responsible to, and each foreman knows that he is subject to the orders of the planning department or the superintendent.

The chart also shows who is responsible for all machines and equipment. The larger and more complex a business, the more important becomes the proper graphical charting of its organization. The case illustrated is a simple one chosen for the purposes of this article.

1-C. The Organization Record

Having determined and charted the organization, the next step is the creation of an organization record. This record consists of a volume containing an exact copy of instructions as issued, covering the duties of each person shown on the organization chart. One of the principles of this form of management is that each and every employee shall have written instructions describing fully his duties and responsibilities.

Although it is not the intention to describe the duties of all the incumbents, one of the succeeding chapters will contain a brief outline of the duties of each person in the production department. These instructions will be a mere summary of the originals, given to illustrate the means employed to make a record of each feature of the new organization as it is developed, to control absolutely and permanently each detail of the business. The appendix contains a number of complete instructions.

It is not unusual to find that an important detail of a business has been discontinued because an employee, originally instructed to attend to that detail, has gone into some other department or severed his connection with the firm. Again, the one in charge, not appreciating the importance of the work, may have neglected to see that it was kept up. Under proper written instructions, which make each detail an essential part of the whole, such an error could not occur. It is impossible to maintain a definite predetermined method of performing a given task without written instructions. Verbal instructions leave no record for future reference. They benefit the one man

instructed. Written instructions are a permanent record to benefit each and every man who holds the position at any time.

One of the chief features of this form of management is a complete and properly indexed record, of all details of the entire scheme of management. This record is a path-finder for the guidance of all the employees after the organizer has completed his work and is no longer connected with the firm.

CHAPTER II

2-A. The Functions of the Sales Department and the Counting Room, which are Divided into Two Sections, with the Secretary-Treasurer in Charge of One, and the Chief Clerk, as His Assistant, at the Head of the Other
2-B. The Functions of the Engineering Room, which is Considered as a Department Separate from the Drafting Room
2-C. The Functions of the Drafting Room

2-A. The Counting Room

In the organization to be described the counting room is suitable for an average medium-sized business. It has at its head an official of the company, the secretary-treasurer, who is personally responsible for the following:

A. Duties as per the by-laws; B. Correspondence; C. Purchases; D. Sales.

A. The secretary-treasurer's duties as an official of the company are clearly specified in the by-laws of the corporation. They include the general responsibilities required by law and need not be taken up here, as they do not particularly affect the scientific methods to be described.

B. The same may be said of the correspondence, which is all of a general routine nature.

C. All purchases are in the direct charge of the secretary-treasurer, as this particular organization is not sufficiently large to warrant one man's entire attention being devoted to this branch of the business. He will be referred to as the purchasing agent. All materials, supplies, etc., to be purchased are requisitioned on the purchasing department by means of a printed requisition form, Fig. 2. This requisition may originate with the heads of any of the departments (see organization chart

REQUISITION FORM F/A.P. 13-A FERRACUTE MACHINE CO.

Date 191

PURCHASING DEPT.—The following materials is required for

JOB, ORDER, ITEM, WORK .....

DELIVER TO ..... Section ..... Space .....

WANTED ..... 191 ..... SIGNED .....

Stores Keeper

SCHEDULE NO. ..... DATE ..... 191 TIME ..... M.

Approved ..... Date ..... 191 Time ..... M.

Entered Stores Card ..... Date ..... 191 .....

Order of .....

Purchase No. ..... Date ..... 191 .....

Purchasing Agent

Purchasing Agent will return requisition to PRODUCTION DEPT.

FIG. 2.—Requisition form.

in connection with Chapter I, Fig. 1), but the majority originate in the planning department. Wherever they originate, they pass through the planning department before reaching the purchasing agent. There they are checked against the stores ledger and are scheduled. After being scheduled, and the time noted thereon, they are forwarded to the superintendent or manager for approval, as the purchasing agent does not honor any requisition which has not been duly approved. The purchase order is made in triplicate under the direction of the purchasing agent. The original white copy goes to the vendor, a yellow duplicate remains on file with the purchasing agent, and a blue triplicate goes to the receiving clerk in the planning department. (See Plate I.) All purchase orders have on the original copy, which goes to the vendor, the prices, terms, etc. These also appear on the duplicate copy for the purchasing agent's file. The receiving clerk's blue copy shows at the bottom the destination of the material in the works, so that when it is received it is moved by the receiving clerk to the department or machine it is intended for. This method saves much trouble and, delay and does away absolutely with the common and expensive annoyance caused by material being received, and the department or person wanting it not being notified of its arrival.

All copies of the purchase order show whether the material is to be charged to stock or to some job in process. When the bill is received it is checked against the receiving clerk's receipt (blue copy of the purchase order), and at the same time a notation is made on it indicating to what it is to be charged. The bill and the receiving clerk's copy are checked off on the schedule (see Plate II) showing the receipt of the material; and then both are forwarded to the stores clerk or to the cost clerk, as the case requires. A great advantage in the scheduling of purchase orders lies in the fact that every day the schedule clerk makes up a list for the purchasing agent, advising him of the

purchase orders which are overdue and for which no invoice as been received. This relieves the purchasing agent of the annoyance of having to personally follow up all of his orders. The scheduling is done by a boy in the planning department and is a simple routine clerical job.

As the " Date Wanted " always appears on the requisition and the purchase order, it is noted on the schedule at the time the purchase order is scheduled. This is an important feature and should be insisted upon. The words " Rush," " At Once," " Hurry," signify nothing, whereas a definite date meets a definite need. If the purchasing agent finds that he is unable to have the material delivered on the date wanted, this date is adjusted to suit conditions. Another advantage derived from insisting on a definite date is that everyone is forced to realize that certain purchases require some time to fill and they therefore become inclined to anticipate their wants. The wording of each purchase order must be complete and specific, and, of course, the same on all three copies. All invoices and shipments are required to show the purchase order number.

A special form is used for all castings, called a casting purchase order, shown on Plate III. This form is in triplicate and in three colors, the same as the purchase order, and is handled similarly, except that the original white copy is returned with the shipment and forms the bill for the castings called for. All casting purchase orders are issued by the production clerk, who is acting in the capacity of assistant purchasing agent. All casting purchase orders are signed for the purchasing agent by his assistant. Only one kind of casting is ordered on a single form and only complete shipments are received.

D. The sales manager, as the title indicates, is the head of the sales department. The following is a brief description of some of the methods employed to develop the sales organization. This development is carried along under four general heads:

D-1. An organized sales department.
D-2. What to sell.
D-3. How much to sell.
D-4. How to sell it.

D-1. An Organized Sales Department. In organizing this sales department it was deemed advisable to handle all sales from the main office of the plant at Bridgeton. The sales manager is especially responsible for the handling of all these sales through his assistants, and he sees that the following card or loose-leaf records are maintained in addition to the regular routine business, correspondence, etc., of this department. These records contain:

1. A list of all the agents with whom the firm does business, with their given territory, volume of sales, men they employ, and all general data regarding them.
2. A record of the sales made by these agents and cost of such sales to the company in commissions.
3. A record of the sales made entirely by correspondence.
4. A record of all sales made by the engineering salesman or other representatives from the office, and the cost of such selling.
5. A record of the percentage of sales to the inquiries received.
6. A record showing why each order lost was not booked, whether due to:
   - 6*a*. Price;
   - 6*b*. Specifications;
   - 6*c*. Delay;
   - 6*d*. Quality;
   - 6*e*. Lack of a proper solicitation of the order;
   - 6*f*. Lack of promptness in following up the inquiry;
   - 6*g*. Design;
   - 6*h*. Deferred purchase on the part of the customer.

Full data are obtained whenever possible for each of the above headings.

7. A complete up-to-date mailing list of all press users or others who should be users. See Fig. 3.

RECORD OF SOLICITATIONS, LITERATURE, Etc.

DATE	INTERVIEW	LETTER	CATALOG	OTHER LITERATURE	BY OUR MR.

NOTE–For record of interviews see SALESMAN REPORT of that date. For other records see correspondence files

Back.

SOLICITATION RECORD FORM F.A.P. 51A FERRACUTE MCH. CO.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Date ..... *19* .....

Firm .....

Street .....

City ..... *State* .....

Business .....

Remarks .....

.....

SEE OTHER SIDE FOR FOLLOW-UP DETAILS

Front.

FIG. 3.—Solicitation record used by sales department in following all matters pertaining to sales.

Agents, salesmen and others assist in keeping this list up by giving the sales department the addresses of those likely to be interested.

8. A record of each concern using the company's product. The record is to be indexed both by customer's name and by territory. It includes data as to the different type and sizes of machines in use by each customer.
9. Data from customers (with samples wherever possible) of results being obtained on widely varying classes of work.

These are to be carefully followed out and cost comparisons made with the old method of using forgings and castings. These data are written up, to be used in circulars, " catch-heads," etc., as advertising material. They have another special value in that they are of great assistance to agents and salesmen, who can often make good " selling talk " out of this information, in connection with the economy of manufacture which they are trying to impress on the prospective customer.

10. A record of all catalogs and price lists sent out. In the case of expensive catalogs or albums a return postal card acknowledging its receipt should accompany it for the prospective customer to return as the company's record that he has duly received it.
11. Stock list of all standard and regular lines of machines are distributed at least once a month.

The above records are essential to the proper solicitation of business, and, of course, must be closely followed up.

The sales manager is also responsible for all dates, quotations, etc., asked for by the prospective customers or agents. These requests must be promptly followed up and those interested must receive immediate attention, whether the requests come from agents or the firm's own representatives. Nothing is so discouraging to an agent or salesman as to have to pacify a prospect to whom he promised certain data which the home office neglected to forward.

The prevailing discounts from lists, if any, should be

strictly adhered to and quotations should always be made in accordance with the prices arranged with the agent, so as to protect all concerned. If in any specific case it becomes desirable to make a special price, all agents likely to be interested should be notified simultaneously and in ample time to revise their figures, so that all have equal chances of winning the order.

Orders sold by agents should be handled through them only. All correspondence should be sent in duplicate to the agent, he to forward the copy to the customer. This method invariably saves a great deal of trouble and misunderstanding, for the agent often "knows his man" better than the firm and can therefore handle the matter much better.

Unusual care is exercised in following up the credit of the customers. This is done through various channels, including the special reports continuously obtained from the credit firms, chiefly Dun and Bradstreet. The result is a remarkably low percentage of bad debts. Terms of payment are standardized and on all special work are so arranged as to cover the cost as the work progresses.

A representative, when traveling, is kept supplied with all information obtainable in connection with the sales pending in the territory he is covering. The daily written reports of all trips are turned in to the sales department promptly and form a complete record for future references as to each trip. This rule is strictly adhered to, whether the trip be for one day or longer. In connection with this item it may be of interest to know that a record is kept in the mailing list, Fig. 3 (on the back of each firm's card), of the date on which a representative called and the person he interviewed. The written reports of all trips are filed in order of their dates. By this means it is easily possible, by referring to the mailing list, to tell when each firm was last interviewed and by whom, and this notation forms a direct reference to the written report of that interview.

Current publications are systematically searched for

reports of new projects or other news which can in any way be followed up with the possibility of securing orders, which results in obtaining information of general value to the sales department. Advance knowledge of the suspected changes, either for better or worse, in business, rise and fall of market value, etc., is all valuable and may save many mistakes, besides assisting in formulating a conservative selling policy.

In dull times a well-organized sales department is extremely necessary, and with properly tabulated data, such as above described, is equipped to do most efficient selling. It is the best asset at such a time the firm can have, and, in fact, is sometimes essential to continuing in business.

D-2. What to Sell. The energies of a well-organized sales department should be directed to the selling of standard and profitable work, and of the kind which the plant is best equipped to turn out. To do this guesswork methods must be replaced by an exact knowledge of actual cost and demand under varying conditions. The complete files of accurate analytical costs alone make this possible. In a later chapter the matter of costs will be taken up fully, and it will be shown that the selling organization now being described has been able, due to lower costs and reduced prices, to solicit and get profitable business which otherwise would have been beyond its reach.

The records which show the volume of business done in various types of machines make possible the absolute control of the kind and volume of stock to be kept finished or in process, with the result that:

1. Plenty of work can be provided for the shops of the kinds shown to be in demand.

2. Only the required amount of stock need be finished or under way to assure efficient selling. This prevents the unnecessary tying-up of capital. A sufficient number of various types of machines can be kept ready for prompt

delivery, or so nearly completed that an early delivery can be quoted.

3. The amount of the business in process of manufacture can be intelligently planned so that work in the shops can go through to the best advantage, at the same time allowing for a closely estimated volume of anticipated business. This has a particular advantage in so balancing stock and work in process for stock that rush orders for this class of work are few and far between. In connection with the planning of the work ahead, preliminaries are continually being arranged between the sales manager and the superintendent so as to anticipate requirements and so utilize time which otherwise would be wasted. Thus much shorter deliveries can be given when quoting a customer, which often results in profitable business.

4. Special work should only be taken when absolutely necessary, and then never on an estimate, but at a price based upon actual cost, plus a percentage of profit, which will guard against loss on the transaction by providing a cost for unforeseen contingencies which otherwise might result in a loss. It is perfectly fair that prices for special work should be higher in proportion than are prices for standard work, and special charges should be made for emergency orders to compensate for the increased cost of turning them out. This is an item which is in the majority of cases entirely ignored.

5. As the manufacturing departments reduce costs, list prices should also be reduced, providing a fair margin of profit can be maintained in so doing. As stated in the opening article of this series, this has already been accomplished.

D-3. How Much to Sell. The increased productive capacity of the works, due to the improved methods being described, has naturally made necessary a more completely organized selling department. The records at hand enable the sales manager to be kept well informed of the capacity of the shop, with the result that a materially increased

volume of business can be handled in a much shorter time, which has the advantage of enabling the sales department to make shorter deliveries than have ever before been possible. Deliveries have regularly been made for standard machines in three to five weeks (with a volume of business averaging over 100% more than had been possible under the old methods on a like class of work) which formerly required from ten to fourteen weeks for delivery. The methods of scientific management have resulted in realizing a productive capacity on this kind of work equal to 300% of that possible under the old and common form of management with the same plant and equipment.

Many firms are to-day drifting along, taking a greater or less variety of work as it comes, without the remotest idea as to what is the most profitable; and without knowing whether they should realize more on their volume of business or not. The fact that the business as a whole is profitable and has been for years is no standard by which to go. Business conditions are changing, and competition is ever narrowing the margin of profit, so that many firms, to continue in the field, must soon do business on an entirely new basis. They must adopt scientific methods in the sales department, office and shops, cut out wastes, reduce the cost of manufacture, increase production, sales, wages and profits, or go out of business.

D-4. How to Sell. This work will not treat of the well-known and perfected methods of instructing salesmen, mapping out territories, planning trips, etc., in use by the best selling organizations, but a word as to the personal factor in selling goods may not be out of place. In the organization which has been developed for selling this particular class of product, it has been essential that the representative on the road should be an engineer with a thorough knowledge of the press and die business to enable him to intelligently solicit profitable business. Thus the traveling force has of necessity been developed from the personnel of the original organization of the company.

This fact has made the development of the sales department much more difficult than in other lines. The key to a successful selling policy is a keen realization of the fact that an order worth having is worth going after.

The personal letter to the user is an aid in introducing a salesman's visit. This letter should be well written and show where the "other fellow," so to speak, is using methods more efficient and economical than are in general use. This kind of a letter can be made more convincing by the addition of a data sheet or photograph with full description of some work being done which is similar to that of the firms whose interest is being sought. Data sheets should be made complete and self-explanatory. In addition to giving an illustration of the piece described, there should be included facts and figures giving an actual record of the cost, production increase, list of operations, etc., including a full explanation of all points likely to prove valuable. Not the least of these is a lighter and better article. These preliminaries are followed later by the visit of the engineering salesman.

The salesman first on the ground has a distinct advantage, other things being equal. When a buyer is in the market for equipment he appreciates prompt and courteous attention, and nothing so much assists him as to be able to talk over all the details of his requirement. A competent salesman can often obtain an order by a personal interview which could not be obtained otherwise. Details can be taken up and explained as good points which would never have been touched upon by letter. This often results in an order going to the firm whose representative is on the ground. A personal interview will often sow the seed of interest which may mature into a profitable order later. A salesman's personality, conversation, etc., will be remembered, where a letter from the firm will often be entirely forgotten, unless it is in connection with some line of correspondence. The representative often learns of troubles or causes for dissatisfaction which otherwise

would never be known and so never explained or corrected.

The subject of sales may not appeal to some readers as being particularly allied with scientific management, but scientific selling is one of its fundamental features. All details are essential in connection with sales as they are scientifically treated, carrying out a policy based upon an exact knowledge of all conditions as to kind and cost of product, requirements of the trade, past, present and possible future developments, here and abroad, combined with the volume of business which it is known will be required to keep an efficient plant employed to its maximum.

DUTIES OF THE CHIEF CLERK

The chief clerk has charge of the regular routine office business, which includes:

1. Bookkeeping;
2. Care of cash;
3. General orders;
4. Pay roll;
5. Charge of vaults;
6. Office records and files.

The only item above of particular importance in connection with the subject is the general order form and the method of originating it, see Plate IV. Orders, upon receipt by the sales department after the *visé* of one of the officials of the company, the sales manager, are passed over to the chief clerk. The chief clerk, preparatory to issuing the general order, accumulates all the required information by consulting the correspondence (including specifications from the customer's formal order), the engineering room, and, if necessary, the salesman who has been instrumental in booking said order. The general order form is made out in triplicate, one copy of which remains on file in the counting room, the second copy going to the engineering and drafting room, and the third copy to the planning

department. Specifications on the general order are divided into sections to suit each individual order. If several machines are ordered, although alike, each one has a separate item and the order number is followed by a letter or letters, as order 3600a or 3600a-d, the latter case indicating that the order has four items, namely, a, b, c and d. The required subdivision of the orders for cost purposes, as well as the complexity of the order, influences the number of items into which it is subdivided.

The original copy, which remains on file in the counting room, has the price and terms of each item plainly stated thereon. This information, however, does not go on the other two copies. As soon as the drafting room determines what drawings, etc., are to be used in connection with the order, the number of them is sent by it to the planning department. The planning department's copy of the general order forms its authority to proceed with the manufacture and shipment of the product called for, and indicates to it how the cost of the job is to be subdivided into its various items. Miscellaneous and repair orders have their costs charged to cost sheets, which bear the order and item number, but machines being built to order are made on merchandise or "M" jobs. These manufacturing job numbers will be explained at greater length in a later chapter.

On receipt of the general order by the drafting room the drawings for it are forwarded to the planning department as soon as possible. If one or more machines are to be built or a number of pieces are required, information as to what is needed is contained on a material list.

On the shipment of an order it is the chief clerk's duty to see that the original copy in the counting room has recorded on it the shipping date and job number on which it was built, as well as drawing number, lists, etc., issued by the drafting room. It is then filed in a vertical filing case in the office vault as a permanent record. The drafting room copy is destroyed at the discretion of the engineering

room. The planning department copy, which contains information as to the jobs on which the different parts were manufactured and other incidental information, is filed in a vertical case in the planning department as a convenient record for later reference. The chief clerk is also responsible for the press record, see Fig. 46 in the Appendix.

2-B. The Engineering Room

The engineering room, as shown by the organization chart, Fig. 1, is in charge of the engineer, with the following associates: Assistant engineer, with one substitute; die engineer, with one substitute; publicity engineer, with one substitute.

The engineering room is responsible for:

1. Estimates;
2. Designs;
3. Experiments;
4. Supervision of new work.

The assistant engineer assumes the duties of the engineer during his absence. The die engineer, as his title indicates, is directly responsible for all die work.

The publicity engineer, while a member of the engineering room, is also connected with the sales department and is the chief assistant of the sales manager. Combined with his engineering knowledge, he has direct charge of many of the records above described in connection with the sales department, and is personally responsible for the solicitation of new business. (See Fig. 3.) His special duties consist of the preparation of all advertising matter and circular letters in the way of giving publicity to the products from an engineering standpoint. All " write-ups," instructions as to the erection and manipulation of the different products, preparation of cuts, catalogs, etc., come under his direct charge. It is one of the theories of this form of management to employ a trained graduate engineer for this work. It is obvious that much of the correspondence

in connection with a business of this kind can be properly handled only by an engineer.

The engineering room, in preparing estimates, receives from the planning department whatever data may be necessary in making up each detailed estimate. These estimate reports are based on the cost record of similar work. When an estimate is required on work which has no record of a past product it is thoroughly analyzed and is subdivided into its individual operations. The immense number of data as to piece and operation costs which are on file in the production department make this a comparatively simple matter, allowing, of course, a reasonable percentage for contingencies and profits. Designs originate in the engineering room, are outlined and more or less perfected, then passed on to the drafting room for details, preparatory to going into the shops. The engineering room compiles data of all descriptions pertaining to the company's product, which data are used in connection with future designs and estimates and also for the publicity work, above referred to, by the publicity engineer.

Estimating and designing of new work, or the issuance of specifications, is one of the functions of the engineering department. Experiments may be in the form of physical tests of materials, or may consist of the test of standard or newly built machines preparatory to shipment.

Supervision of new work is one of the important functions of the engineering room. All new work is under the supervision of the engineering room through the superintendent during its progress through the shop. On the completion of the machine, or mechanism, it is finally inspected and passed on by one or more of the engineering staff, and whatever data are required are taken prior to its shipment. An exact record of special features in connection with new work is kept by the engineering department for future reference and record. As the engineering room originates all new work, it is obviously the only department fitted to

intelligently and satisfactorily pass on it, and must assume the responsibility for its final perfection according to specifications.

2-C. Drafting Room

The drafting room is in charge of the chief draftsman, who has one assistant. From the drafting room, under the general supervision of the engineering room, originates all:

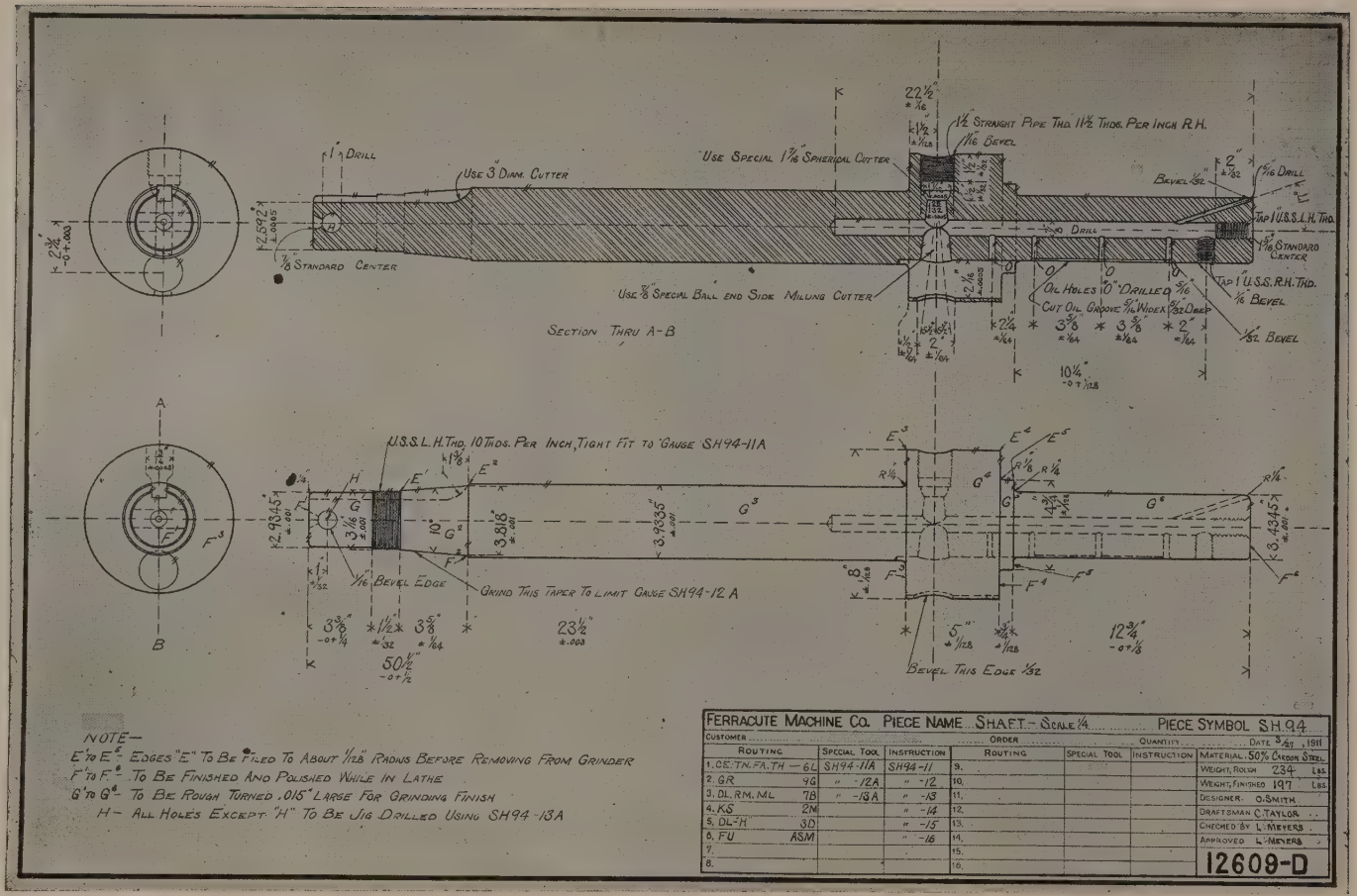
1. Information;
2. Sketches;
3. Drawings;
4. Tracings;
5. Blue-prints;
6. Material lists;
7. Photographs;
8. Standards.

All of the above, subject to the approval of the engineering room, go to the shop through the superintendent and the planning department. The latter is the clearing house through which all information is subdivided, routed and distributed to the various departments.

1. Information in some extreme cases is issued from the drafting room in the form of crude sketches, although usually blue-print sketches, detailed drawings and material lists form the mediums used to advise the planning department of what is required to fill an order.

2. All sketches (size 8 by 10 inches) are first drawn in pencil on thin bond paper and when approved are inked in to form a negative from which to blue-print. The blue-prints are issued in duplicate to the planning department, where one copy is kept on file for use in planning, routing and pricing the work. The second copy is forwarded by it to the tool room, where it is kept on file to be drawn out by check as a tool.

3. The following sizes of paper only are used for drawing:



NOTE—
E to E⁶ Edges "E" To Be Filed To About 1/128" Radius Before Removing From Grinder
F to F⁶ To Be Finished And Polished While In Lathe
G to G⁶ To Be Rough Turned .015" Large For Grinding Finish
H— All Holes Except "H" To Be Jig Drilled Using SH94-13A

FERRACUTE MACHINE CO. PIECE NAME SHAFT — SCALE ¼ PIECE SYMBOL SH.94

Customer ... Order ... Quantity ... Date Oct 3, 1911

Routing	Special Tool	Instruction	Routing	Special Tool	Instruction
1. CE. TN. FA. TH — 6L	SH94-11A	SH94-11	9.		
2. GR 9G	" -12A	" -12	10.		
3. DL. RM. ML 7B	" -13A	" -13	11.		
4. KS 2M		" -14	12.		
5. DL-H 3D		" -15	13.		
6. FU ASM		" -16	14.		
7.			15.		
8.			16.		

Material .50% Carbon Steel
Weight, Rough 234 Lbs.
Weight, Finished 197 Lbs.
Designer O. Smith
Draftsman C. Taylor
Checked By L. Meyers
Approved L. Meyers

12609-D

FIG. 4.—Drawing showing form of standard label used and the system of clearances and tolerances.

Sketches, 8×10 ins.;
C Sheets, 9×12 ins.;
D Sheets, 12×18 ins.;
E Sheets, 18×24 ins.;
F Sheets, 24×36 ins.

All detail paper is thin white bond, ruled in red ink in one-inch squares subdivided by finer red ink lines into one-eighth-inch squares. This is used as a negative from which to make the blue-print in the same way as explained above for sketches. The negatives referred to remain in the drafting room and are filed in fireproof vaults. A single piece is shown on a sheet, and as many views are drawn as are necessary to clearly depict the piece. Each dimension is marked with a plus or minus tolerance and allows for the required clearances to assure proper assembling of the parts in the completed machine.

The reproduction of the drawing herewith, Fig. 4, illustrates the form of standard label used on all details, including sketches, and it will be noticed that the route of the piece through the shop is specified, giving the sequence of the operations (general operations), their symbols and any special tools which are to be used in connection with the performance of such operations. The use of clearances and tolerances is shown. The rough weight and finished weight are shown on the drawing, and the draftsman's name and names of the persons sketching and approving each drawing. The customer's name and the order number are specified on all transient work. The detailed instructions issued for each operation are also referred to.

When necessary, reference marks are put on the drawing to use in connection with the routing specified in the label, so that when the detailed blue-print leaves the drawing room and goes to the planning department, all the necessary information is contained thereon to insure the proper routing and machining of the piece. Nothing whatever is left to the whim of the individual workman, and all information that is essential for him to have in the proper

performance of his work is given. This has the advantage of making the routing on standard or repeat work a simple clerical job.

In figuring dimensions a tolerance table is used, which is a guide to the drafting room and gives the clearances to allow, consistent with the practices required by this particular type of work. The sizes of the centers to be used in all lathe work are also specified. The responsibility for the determination of the correct size and shape of each piece and the quality of the finish required, lies with the drafting room and not with the individual workman or shop boss.

A long step towards the economical production of a piece has been taken when a proper detail drawing of the kind described has been made. Few managers realize the time wasted in the shops through incomplete and improperly figured drawings. The use of clearances reduces the scraping and fitting on the floor to a minimum, and in many cases has alone reduced the assembling time 50%. Tolerances, under proper inspection, insure the required accuracy, and eliminate much time wasted in doing close machine work to some dimension which is unnecessary. An additional length of $\frac{1}{4}$ in. or $\frac{3}{8}$ in. on a shaft, due to the forging coming a little long, often is not detrimental, and the time required to face this off to the drawing length is saved if the proper tolerance is marked on the drawing. Belt wheels can ordinarily have a tolerance of 1-16 in. to 1-8 in. in diameter or face, or both, thus saving time that would otherwise be used in making work close to the nominal dimensions. No time is wasted by the workman or gang boss in finding out the best way to do work, as this has already been planned and the detail instructions written out. The instruction card will be described in a later chapter.

The author has known many shops remarkably inefficient chiefly because they did not have proper drawings. In one case, where 28-ft. box cars were made, the only

drawing the forge shop, employing 30 to 40 men, had to work from was a one-eighth scale blue-print of the assembled car. Every piece of iron except the castings had to be made from this drawing. In another case, where a large amount of shafting was used for a number of standard types of machines, the men running the cutting-off and splining machines were the only ones in the entire works of 400 to 500 men who knew the dimensions of these parts. One man used measuring sticks which were longer or shorter than a given shaft was to be, and he alone knew how much to add or subtract. Practically no drawings were in use in this entire plant. The workmen themselves were the only ones who knew the dimensions of the individual pieces. In still another instance many pieces were originally detailed on one sheet, and it was not an unusual occurrence for four or five men from various parts of this shop to be congregated around this one drawing, as it was the only record in existence of the various pieces these men were working upon. Proper individual detailed drawings in blue-print form soon solved the problem in each example cited.

TABLE OF CLEARANCES AND TOLERANCES USED—(INCHES)

A. NOMINAL SIZED HOLE

0.0	to	0.5	±0.00025
0.51	to	1.0	+0.00025 −0.0005
2.0	to	6.0	±0.0005
7.0	to	12.0	±0.001

B. DRIVE, PRESS, OR SHRINK FITS

To male piece 1.0	diameter add 0.00075	±0.00025
To male piece 2.0	diameter add 0.0015	±0.0005
To male piece 3.0	diameter add 0.0025	±0.0005
To male piece 4.0	diameter add 0.004	±0.001
To male piece 5.0	diameter add 0.005	±0.001
To male piece 6.0	diameter add 0.006	±0.001

C. Running Fits

For journals with usual ratio of length to diameter and sliding or oscillating fits, usual ratio of length to diameter.

Male piece	0.5	minus 0.00075	±0.00025
	1.0	minus 0.0015	±0.0005
	2.0	minus 0 002	±0.0005
	3.0	minus 0.003	±0.001
4.0 to	6.0	minus 0.004	±0.001
	7.0	minus 0.005	±0.001
8.0 to	10.0	minus 0.006	±0.001
	11.0	minus 0.007	±0.001
	12.0	minus 0.008	±0.001

D. Special Fits

Use this table for gear fits, fast pulleys, C-press shaft boxes, clutch studs, and like work not running or loose, but which can be put together with hand raw-hide. *Note.* Also adapted for RUNNING FITS for such work as "P-Press" eccentrics and work with length of bearing of one-half diameter or less.

Male piece	0.5	diameter	minus 0.0005	±0.0001
	1.0	diameter	minus 0.00075	±0.0001
	2.0	diameter	minus 0.001	±0.0002
	3.0	diameter	minus 0.0015	±0.0003
4.0 to	6.0	diameter	minus 0.002	±0.0005
	7.0	diameter	minus 0.0025	±0.0005
8.0 to	10.0	diameter	minus 0.003	±0.0005
	11.0	diameter	minus 0.0035	±0.0005
	12.0	diameter	minus 0.004	±0.0005

E. Special Easy Drive Fits

Suitable for such work as pinion and pinion wheel fits, etc., that can be driven by hand. These fits will be tight enough not to wobble. These fits must not be depended on to do any amount of work without keys or set screws. Suitable for fits of any length.

Nominal size holes, 0 to	1.0	—.00025	+0
	2.0 to 6.0	—.0005	+0
	7.0 to 12.0	—.001	+0

Nominal size male piece	5	diameter	+ .0001	— 0
	1.0	diameter	+ .0001	— 0
	2.0	diameter	+ .0002	— 0
	3.0	diameter	+ .0003	— 0
	4.0 to 12.0	diameter	+ .0005	— 0

The advantages of specifying the route of the piece or the sequence of operations will be taken up later, together

MATERIAL LIST — FORM F. A. P. 11 a — FERRACUTE MACHINE CO.

DATE July 5, 1911.

MATERIAL REQUIRED FOR 1 Press P 5

FOR C. C. Warner Mchy. Co.

QUANTITY	NAME OF ARTICLE	MATERIAL	PIECE SYMBOL	DRAWING	SIZING	REMARKS
1	Bolster	I.C.	B1P5a		3766	
4	Bolster clamp	S.C.	B2-3a		3886	
4	" " bolt	Mch.S.	B3-3a	12A-B		
4	" " nut	S.C.	B4-3a		3892	
2	Bolster die bolt	Mch.S.	B5a	80-B		
1	Clutch slide	CHROME NICKEL STEEL	CP1-11b		5004	
1	Beam	BEST GRADE CRUCIBLE CAST STEEL	CP2-11b		5030	
1	" pusher	TOOL STEEL LONG GRADE	CP3-11b		3989	
1	" spring	Brass	CP4-11b	12897-C		
1	" gland	I.C.	CP5-10b		5136	
1	Lock	M.I.	CP6-11b		5109	
1	Clutch slide bushing	KIAX MANGANESE BRONZE	CP7-11b		3788	
1	Clutch lever	S.C.	CP8-11b		3588	
1	" " stud	Mch.S.	CP9-11b		5130	
1	Lever spring	Brass	CP10-11a	12899-C		
1	" " hook	W.I.	CP11a		5061	
1	" " bolt	Mch.S.	CP12a		5103	
1	Upper brake	I.C.	CP13-11b	66-D		
1	Lower "	"	CP14-11b		3648	
1	Upper brake leather	Leather	CP15-11b	258-C		
1	Lower " "	"	CP16-11b		5123	
12	Brake shoe	Wood	CP17a		5102	
1	" bolt	Mch.S.	CP18-11a		5094	
1	" spring	Brass	CP19-11a	238-C		
1	" stud	Mch.S.	CP20-11b		4097	
1	" stud washer	W.I.	CP21-11a		5067	
1	" adj. screw	Mch.S.	CP22-11a		5056	
1	Shaft collar	I.C.	CP23-11b		5023	
1	" " screw	Mch.S.	CP24-11b		4023	
1	Frame	I.C.	F1P5a	10184		
2	Lib	"	F2P5a		3619	
3	" set screw	Mch.S.	F4P5a		3555	
6	" bolt	"	F5C5a	321-C		
4	Bed bolt	"	F5P5a		4078	

LISTED P. H. CHECKED J. G. APPROVED L. V. M. ORDER 27264a.

3 SHEETS, SHEET 1

FIG. 5.—Material list; one of these is made for every order requiring more than two or three pieces.

with how the information on this point is obtained for the draftsman.

4. Only in exceptional cases are tracings made on muslin tracing cloth.

5. Blue-prints are considered as tools, and are issued by the drafting room in duplicate to the planning department. One copy is used by it as its record from which to analyze, plan and route all work. The shop prints are kept in the tool room on file, to be called for by the gang bosses. These are only issued on check as a tool. When not in use they are returned to the tool room.

6. A material list is made for each order calling for a machine and for any order requiring more than a few pieces. This material list bears the customer's name, date and order number and a brief heading showing what the parts listed are for. Each piece required to fill the order is specified, giving the:

1. Quantity;
2. Name of Piece;
3. Material;
4. Symbol;
5. Drawing or Sketch Number;
6. Remarks.

See the production of material list herewith, Fig. 5.

The material lists are blue-printed and issued to the planning department in duplicate, the same as drawings. The original or negative is filed in the drafting room vault according to order number. As all machines shipped bear a shop number of which a record is kept in a card file (see Fig. 46 in Appendix), it is a simple matter to replace any part. This card refers to the order number or standard list on which each machine was built, thus forming an index by which the material list is quickly located.

7. Photographic work is also done by the drafting room. All new work is photographed before shipment, as well as any work having special features or improvements.

8. Standards as soon as determined are recorded and filed by the drafting room. A list of all standards and special tools is also kept for the use of designers and draftsmen.

CHAPTER III

3-A. The Planning Department
3-B. Duties of the Superintendent
3-C. Functions of the Planning Department
3-D. The Production Clerk
3-E. The Shop Engineer
3-F. The Stores Clerk
3-G. The Cost Clerk
3-H. The Route Clerk
3-I. The Order-of-Work Clerk
3-J. The Shipping Clerk
3-K. The Receiving Clerk
3-L. The Time Clerk
3-M. The Schedule Clerk
3-N. The Factory Mail System
3-O. The Time Boy
3-P. The Inspector
3-Q. The Stores Keeper
3-R. The Move Material Boss

3-A. The Planning Department

The planning department presents the first radical change from the old type of organization to the new system of management founded upon scientific principles. The change is so radical that it is perhaps responsible for more adverse criticisms than any other one feature of scientific management. These criticisms are most unjust and prove by themselves that they are founded on nothing but hearsay or ignorance. That the planning room is employing a number of so-called non-producers, which is unheard-of in the common form of organization, seems to be sufficient reason for supposing that the cost of the product is being greatly increased. There are sometimes three or four times

as many printed forms in use as formerly, and the item of stationery expense is often commented upon. The fact is entirely overlooked that the work done by a few additional men (so-called non-producers), specially trained for their clearly defined duties, and responsible for their own specific functions, is putting the workmen (so-called producers) in position to devote their entire time and energy to the work of producing.

These few specially trained men plan and analyze all work, methods, etc., and prepare the way for the workman to produce at his highest normal efficiency. They are skilled in the elements of analysis as he is in the arts of his trade. The workman should take none of his time for preparatory work; though under the common form of management he is often expected to do so, even while much valuable equipment is lying idle a greater or less percentage of the time. Idle machines and equipment represent a big monetary loss per hour, to say nothing of the wages paid a high-class mechanic, who is obliged to take his time to hunt up his foreman, move material for his next job, or grind his tools, etc. Furthermore, where this work is attempted by each man independently, there exists no known degree of efficiency. Scientific methods prevent the waste due to idle equipments plus no production, and through the planning department a clearly defined "best way" is established to reach a required degree of efficiency. The only time to establish a "best way" to reach the required efficiency in the production of each and every piece is before a cent has been spent for either material or labor. When the design of a job has been perfected, the proper detail drawings completed, and the work analyzed into its various elements and definitely routed in its future progress through the shops, the greater part of the work has been accomplished.

During the discussion of a paper on "Shop Management" presented by the author before the New England Railroad Club, a member stated that the railroad manager disliked

to hire even one clerk, to say nothing of several, and that it was easier to get his consent to hire ten machinists than to hire one clerk. A case was cited of one railroad shop employing four hundred men with three clerks in the entire establishment. This is an error of judgment that is far too common, and it is a most short-sighted policy. The inefficiency of the shop referred to can readily be imagined.

The adapted methods being described, and which are suitable for a shop of one or a few hundred men, will require about six additional employees in the new functional positions which would not be considered necessary under the common type of management. The cost of these additional six men in wages is about $4,000 per year. Add to this $1,000 for additional stationery, office room, etc., and a total of about $5,000 represents the actual permanent outlay per year that can be directly chargeable to the new type of management in a plant of this size. As will be shown in the concluding chapter, the installation of the methods under description, including this extra planning department expense of $5,000 per year, has resulted in more than doubling the production of the same plant and equipment employing less than two hundred men. This statement entirely excludes the gains made by the bonus system of payment. Is this not a gilt-edge investment? The increase due to the bonus system in connection with the time study and instruction cards represents the final development of the entire scheme and has resulted in again more than doubling the original output. It obviously makes no difference whether the total money paid out in wages is distributed between so-called non-producers or productive labor, so long as the total cost of the product is less. In the common type of organization much responsibility is shifted from the shoulders of the managers of the business (where it rightfully belongs) to the shoulders of the men in the shop. The latter are expected to be mind readers, clerks, and executives, in

addition to being first-class craftsmen. Scientific Management creates a proper department of competent and specially trained men and places all responsibilities where they belong.

The science of management requires a clerical force to investigate, compile data, and utilize the knowledge so obtained to the mutual and permanent assistance of the firm and its employees. Let the critics investigate, contrast and compare the results obtained by the new over the old form of management, and their arguments must cease. The odds are at least three to one against them, based on the actual records of any line of business which they may investigate, working under scientific management. In every shop run under scientific methods will be found contentment and high wages for the workmen combined with a hearty spirit of cooperation with the employer. Not one shop in a hundred under the common form of management can boast of this condition.

3-B. The Superintendent's Duties

Before taking up in detail the functions of the planning department, the position and responsibilities of the superintendent will be outlined. Referring to the organization chart shown in Chapter I, Fig. 1, the status of the superintendent will be seen at a glance. He is at the head of the manufacturing departments and is directly responsible to the general manager. His duties and responsibilities require him to:

a. Strictly adhere to the system and keep it running smoothly in the manufacturing and planning departments.

b. See that all department heads and those under them have proper written instructions which must be strictly followed. The planning department particularly must keep its work up to date. It is fatal to allow routing, stores or cost keeping to drift.

c. Maintain the proper discipline in all departments of the works and to enforce strictly all shop rules.

d. Preside at a foremen's meeting to be held at least every two weeks. This is the best means of bringing the department heads, functional foremen, and gang bosses in touch with each other and with the company's officials. It provides a means to explain the company's policy to the men, and it gives the men an opportunity to make suggestions. It assists in smoothing over troubles and misunderstandings arising during the day's work, etc., and it is an excellent medium for promoting a proper feeling of personal interest and responsibility among the employees. Their more intimate knowledge of the details, tools and equipment especially fits them to bring up for general discussion many matters requiring adjustment. The superintendent should instruct those present in the working of the new type of organization and explain its practical advantages. The foremen's meetings keep them in touch with the company's policy on all points affecting each.

e. See that plant, factory and other property are maintained in an A1 state of repair and are at all times properly protected from fire and vandalism, and, so far as possible, from the elements. The superintendent must be thoroughly informed on all labor laws, as to the employment and care of help, their working hours, accident liability, etc., and must forestall accidents as much as possible.

f. Maintain an up-to-date schedule which shall show two to four weeks prior to the delivery dates of the various orders, what work is necessary to make ready the several parts for the erecting floor, in time for shipment on the date promised. This forms an efficient means of knowing well ahead whether the delivery can be made on time, and gives ample opportunity to notify the sales manager in case of delay.

g. Name delivery dates on all new work in connection with quotations. Reports and data on hand in the planning department make this a comparatively simple matter.

h. See that the material lists and items of general

information for all work on hand are promptly forthcoming from the drafting room. He exercises direct supervision over the pattern shop and arranges in a broad and general way with the production clerk for the requirements for castings from the foundry.

i. Assume direct charge of all new work which has not previously been built, and be responsible for carrying it through according to orders, under the general supervision of the engineering room. Work of this kind is in charge of one man or a temporary gang boss detailed for the work by the superintendent.

j. Control the amount of stock, or standard parts, to be kept on hand or in process, and determine this amount by consulting the records. These records give him an exact knowledge of the quantities consumed for a given period under different conditions of business. The known demands, or the limits due to the financial investments involved, considering the economical manufacture of the parts under the new methods, control the quantity. In connection with this latter item, he consults with the secretary-treasurer. Stock and standard work, above mentioned, is scheduled and brought through in the same way as work on order, and the completion dates are planned as though these goods were already sold.

k. Be responsible for the anticipation of all orders for all kinds of rough material, especially iron castings. He must see that the foundry is kept supplied with work on verbal or conditional orders from the production clerk, so as to enable the foundry to work on the standard parts, up to certain limits, in connection with the other work. These parts are held by the foundry pending a formal order from the production clerk. This gives the foundry an opportunity to make these parts to the best advantage and work them in as most convenient, at the same time forming a stock which can be drawn on at a day's notice.

l. Attend the factory board meetings which are held every morning, except Saturday, in the manager's office.

The manager presides at these meetings. The superintendent, assistant superintendent, production clerk, order-of-work clerk and chief draftsman are present, as is also the vice-president of the company. At these meetings all routine work of importance is taken up, planning is done on work for the immediate future, and reports are made on routine business generally. Stenographic notes are taken of these meetings and typewritten reports handed to each of those present within half an hour after the adjournment. This forms an efficient means of keeping the different members of the organization in touch with each other and posts them on just what is being planned in connection with all work in the manufacturing departments. All complaints from customers, as well as from the management, are taken up at these meetings, and the responsibility for errors placed where it belongs. The happenings are private and confidential. Criticisms are often pointed and personal, involving those present when necessary, but only in a spirit of absolute fairness and for the instruction and good of the ones involved. The members all appreciate this and profit thereby. A matter once thrashed out is settled for all time, and is not brought up again.

3-C. Functions of the Planning Department

Reference to the organization chart (Chapter I, Fig. 1) shows the planning department to be in charge of the production clerk. The production clerk has one substitute who assumes his duties during his absence. Those employed in the planning department proper are as follows:

a. Production Clerk;
b. Shop Engineer;
c. Stores Clerk;
d. Cost Clerk;
e. Route Clerk;
f. Order-of-work Clerk;

g. Shipping Clerk;
h. Receiving Clerk;
j. Time Clerk;
k. Schedule Clerk;
l. Factory Mail Boy, and
m. Time Boy.

In addition to the above, but directly responsible to the production clerk, the shop employs the following:

n. Inspector;
o. Stores Keeper;
p. Move Material Boss.

The three last named are all functional foremen, each having specific duties which are clearly defined in writing, and which may bring all of them successively in touch with each and every man in the shop. They practically form the shop representatives of the planning department, which really controls and runs the shop through them. Those employed in the planning department are likewise filling functional positions, as will be shown in the following résumé of the duties of each.

The space devoted to this subject will not allow of a complete detailed description of the duties of all these functional employees. The original typewritten instructions to these men, covering the duties to be outlined below, are made very complete and are issued to each incumbent of the various positions. They represent probably two hundred closely typewritten pages, so that an idea may be formed of the complete way in which all details have been worked out. They will be taken up in order. See sample instructions in the Appendix.

The accompanying photographs show the planning department of the Ferracute Machine Co. This room is divided into two parts. One, the Controlling Section, Fig. 6, is responsible for the planning, routing, methods, order of work, etc. The other, or the Statistical Section, Fig. 7, has to do solely with material, values, time, wages, etc.

FIG. 6.—The Controlling Section of the Planning Department; all planning, routing and time study work is done on this side of the room.

FIG. 7.—The Statistical Section of the Planning Department; this side has to do solely with material, values, time, wages, etc.

3-D. The Production Clerk

The production clerk is at the head of the planning department, and is directly answerable to the superintendent. He must be thoroughly conversant with all of the duties of each of the men under him, and he is held responsible for them and their work. The production clerk personally supervises the requisitioning of all material (except gray iron castings) for work on order or for stock. As the assistant to the purchasing agent he personally orders all iron castings direct from the foundry.

He is responsible for the prompt checking of material lists against the stores ledger, after which he must see that the work is promptly analyzed, routed and planned to completion so that it reaches the erecting floor in sufficient time to meet the delivery date.

At the end of each month the production clerk prepares a monthly report, of which four typewritten copies are made. One of these copies remains on his file, one goes to the secretary-treasurer, one to the assistant engineer (who is a director of the company) and one to the organizing engineer. This report contains the following:

1. Inventory at the end of the preceding month consisting of:

   a. Classified list of all stocks on hand;
   b. Detailed list of all machines in process;
   c. Detailed list of all orders in process unshipped; and
   d. Detailed list of all stock work in process.

2. A detailed list of all charges to plant, for the previous month.

3. A detailed list of all operating expenses divided into two groups, one covering shop-keeping, and the other business expense.

4. A report on the distribution of wages and salaries into business, shop-keeping, factory, plant and productive labor. A summary of the above, with a statement show-

ing the prevailing overhead charge per hour. This is determined by the division of the total shop-keeping and business expense by the total productive hours for the period. This statement also shows the average expense per productive hour for the year to date. It is thus a simple matter to know whether the total expense actually distributed to merchandise work is enough to cover the actual expense incurred in the running of the works or not. This affects vitally the accuracy of the costs.

3-E. The Shop Engineer

The shop engineer ranks almost in importance with the superintendent, and in the particular organization which is being used as an example throughout this series of articles, the position is being filled by the assistant superintendent. His duties are outlined in such a way as to make him, in an *ex-officio* capacity, responsible for the tool room and the care and maintenance of the power plant and like equipment throughout the works. The position naturally requires a complete knowledge of all the details in connection with the above, and can only be properly filled by a practical man continuously in touch with this part of the equipment. The shop engineer also is responsible for the methods employed in the manufacturing of the product. The routing shown on the drawing in Fig. 4, Chapter II, is obtained from the shop engineer by the drafting room. These methods involve the control of the tools, speeds, feeds, and cuts used in connection with the different operations, and, as a natural result, the time-study man is directly under the shop engineer. The planning of all tools and jigs, and the most economical method of production of a piece in a large shop is directly up to the shop engineer. As can easily be seen, this is one of the most important functions in connection with scientific management. The shop engineer must be conversant with all types of machine tools, must know the

best kind and sizes and shapes of tools, and understand their construction, range and capacity, as well as the advantages of one make over another. He must know the best combinations of speeds, feeds, and cuts, and understand high-speed steel, its use, treatment, etc. The jigging of work, and the designing of special tools and fixtures are some of his duties. As the seventh chapter will be devoted exclusively to the matter of methods, tools, time studies, etc., the subject will not be taken up at any length now. This is a distinctly functional position and, as can be seen, brings a new feature into shop management.

3-F. The Stores Clerk

The stores clerk has charge of the stores ledger, which is in card form and represents a perpetual inventory of all the rough and finished stock on the premises. The stores card is 5×8 ins. A separate card is kept for each individual piece or kind of stock. This card gives a record of the stock orders, time ordered, and the date each lot was received. The quantity, price and total value of the stock is also shown. The card shows the amount of stock consumed in a given time, as well as to what each piece or lot taken out was charged. A unit balance and a cash balance is maintained on each card. The stores ledger in use at the Ferracute Machine Co. consists of between six and seven thousand cards, and about eight hours' work at the end of each month enables the stores clerk to draw off a classified memorandum for the production clerk's report of all stock on hand at the end of the month. This record makes it a simple matter to determine the consumption of each variety of stock, to assist in the regulation of stock when ordering a fresh amount, and does away with the possibility of maintaining an unduly large stock of any one article. A record is kept of the debits and credits to stock, to form a check at the end of the month to insure against error. The stores ledger forms a valuable index record of the cost

of each piece or kind of stock, and is a direct reference to the purchase number for stock purchased outside. It is of immense value to the engineering room in making estimates. The fifth chapter will take up in detail the stores department and will show how material is put into, and taken from, stores, and will give illustrations of how stock is stored, etc.

3-G. The Cost Clerk

The cost clerk is responsible for all cost sheets, on which are posted all materials requisitioned from stores or from outside purchase. The sheets also carry a record of all time expended in the shop either as expense or work in process. All time posted on the cost sheets is distributed daily into a daily wage distribution book, which agrees with the similar entry made daily by the time clerk, so that the time card coupons from which these postings are made are sure to agree with the total on the man's time cards, as shown by the time clock. A limit of error not to exceed four hours in time, or one dollar in money, or both, is allowed to go uncorrected per week. In this way there is no possibility of distributing more or less time to the cost sheets than is paid for according to the time clock cards. The fifth chapter will take up in detail (under 5-D) the form of cost sheet used, and will show how these various charges are checked and recapitulated on the sheet in such a way as to absolutely preclude any chance of error.

3-H. The Route Clerk

The route clerk represents another radical departure from the common form of management. All work is analyzed by him according to the detailed drawings emanating from the drafting room, and a "next-work order" form is made out in triplicate for each operation for each piece required to fill an order. The material list has already been checked off from the stores ledger and material not

on hand ordered by the production clerk, after which it is passed over to the route clerk. From the material list the route clerk accumulates the detailed drawings which have been issued by the drafting room and makes out the work orders referred to above. These orders are written out in triplicate; one copy remains in the time boy's file, the second one goes to the routing rack in the planning department, and the third one to the rack in the department in which the operation called for is to be performed. Each "next-work order" has a different work number, to which time in the shop is charged. As each piece is routed by the route clerk, he fills in at the top of the schedule cost sheet the name of the piece and the successive operations, in their proper order, showing the operation, the machine, the department, and the next-work order number. The sheet then goes to the cost clerk and is put on his file in its proper numerical position. The route clerk must of necessity have an adequate knowledge of all the equipment in the shop, its capacity and the location of the various machines. When routing work he consults the routing rack at his side to avoid causing a congestion of work at one machine with a corresponding lack of it at another. In cases where only one or two machines in the shop can perform a given operation, there are times when congestion cannot be avoided, but usually the work can be distributed to one of the several different machines of a similar type and size.

The two copies of the next-work order which remain in the planning department show the job to which the piece called for belongs. The gang boss or shop time clerk in the shop charges the time expended on each operation against the next-work order number, which number is transposed on the next day by the time boy into the job number to which the piece is to be charged. All work, with few exceptions, is done on a next-work order. The advantage of this is that the cost of each operation is easily obtained, and the planning department is sure to

know of all work which has to be done over for any reason whatsoever. The next-work order form in addition to specifying the machine, department, number of pieces, operations to be performed, drawing number, instruction and bonus chart numbers, etc., also has clearly noted on it the destination of the piece. As soon as the gang boss has completed the operation called for, he signs his copy of the next-work order and passes it to the material move boss, who moves it to the destination specified. He then sends it by the factory mail boy to the planning department. The subject of routing will be taken up in greater detail in the fourth chapter, under 4-A.

3-I. The Order-of-Work Clerk

The next radical departure is the detailing of one man to be entirely responsible for the order of work in the shop. This man must be thoroughly familiar with all machines, their range and capacity, so that in his routine work of continually rearranging the order of work (to get specified deliveries) he will be able, if necessary, to suggest different routing to the route clerk to enable him to meet the requirements. As practically all work routed specifies the machine, the order-of-work clerk, by simply rearranging the next-work orders in the rack in the planning department, is able to control the order in which this work will be done in the shop. A word of explanation will be necessary at this point to clearly explain how this is done in connection with the route board or rack shown. See Plate VI. This rack has three compartments for each machine or bench in the various shops, which contain the orders for work going to these machines or benches. The top compartment holds the one work order on which the machine or bench is at the time working. This rack has a duplicate in the different departments in the shop from which the gang bosses or foremen take their next-work order from the front of the middle compartment. The lower compart-

ment in the shop rack holds the work orders for material not yet arrived at the machine. This next-work order is moved up to the second compartment when the material move boss leaves the material at its destination. As the gang boss is instructed to take only the front order from the middle compartment, it is obvious that the order-of-work clerk can absolutely control the work in the shop by the proper arrangement of each order in this middle compartment.

As stated above, the order-of-work clerk is present at the factory board meetings and is kept informed of the importance of the different jobs, to enable him to bring the various parts through for completion in the proper time. He has the schedule cost sheets to refer to, which keep him informed as to just where each piece is in the shop, what operations have been performed on it, and also what work remains to be done on it. The fourth chapter will take up in further detail the functions of this position under 4-D.

3-J. The Shipping Clerk

All shipping is in the sole charge of the shipping clerk, who receives from the superintendent his orders pertaining to the shipment of a machine. All miscellaneous work is in the special charge of the assistant manager, and he notifies the shipping clerk in sufficient time to enable him to make proper arrangements for the shipment of this class of work as soon as completed. The shipping clerk, being one of the planning department force, has access to the files and makes all shipments in accordance with the specifications and instructions on the general order. See Plate IV. Under no circumstances does he make shipment without the general order as his authority.

3-K. The Receiving Clerk

The receiving clerk, as previously stated, is kept supplied with a copy of all purchase orders, and also of all casting purchase orders. See Plates I and III.

Material received is checked off by him to the specifications appearing on his copy of the purchase order, and, after it has been examined and O.K.'d by the inspector, he sees that it is moved to the destination called for on the purchase order. He also sees that the work orders in the route racks are moved up to the middle compartment. As each shipment is received, it is noted on the purchase order, and if only a partial shipment, the date and amount received at each shipment. This enables the cost clerk to properly check up and charge all material, using both the invoice and the receiving clerk's copy. If it is an express shipment, or should there be a cartage charge, the receiving clerk notes on his purchase order the amount of the charge.

3-L. The Time Clerk

The time clerk is responsible for the correctness of all clocks in the shop, including the clock on which the men register in and out. He is required to watch the clock during the time the men are registering, so as to see that each man registers only his own card. Each day the clock cards are checked up and totaled, the totals being checked against the individual time card for each man as turned in by the gang boss or foreman. This insures the proper distribution of the exact amount of time which is shown by the time-clock cards and for which the men will be paid. This time is daily totaled and distributed into the daily wage distribution book, which, as above stated, in connection with the cost clerk's duties, must agree with the cost clerk's entry. The time clock is arranged with a decimal wheel so that all time is stamped on the time clock in hours and hundredths. For example, if a man registers at twelve minutes of seven in the morning, his time card will show 6.80, or should he register at three minutes of seven, his time card will show 6.95. All time is paid for in hours and tenths, and if a man gets to work late

in the morning, his time commences on the next following tenth of an hour. If a man commences to work at ten minutes past seven in the morning, his time begins at 7.2, or should he leave at ten minutes of twelve, he is paid only up to 11.8. The gang boss or shop time clerk in registering time for the men on the job time cards, records the nearest tenth of an hour. To assist in this, all time clocks have a special dial marked in large, red figures to show each tenth of an hour in addition to the twelve regular hour marks. The fifth chapter (under 5-C) will treat in detail of the form of card used to get the returns for each man's work daily, and show the method employed. One important feature in this form of management is that the workmen have absolutely no clerical work whatever to do and it is not necessary that they touch a pencil or time stamp from the time they arrive at work in the morning until they quit at night.

3-M. The Schedule Clerk

All purchase orders and casting purchase orders are scheduled on a large sheet ruled in vertical columns. See Plate II. Each item purchased is briefly noted at the head of a column, and the date requisitioned and ordered is noted further down the column opposite the date on which each occurred. The left-hand side of the sheet is numbered from top to bottom in calendar days; these calendar days correspond to the stations in a railroad time table. The "date wanted" of each item is also noted on the schedule in red. It is the schedule clerk's duty to make out daily for the purchasing agent a list of all purchase order numbers for material not received within at least a day of the date ordered. These lists are called "urgers," and as each item is urged, the symbol used, namely, UR, is noted in the proper column opposite the date of such urger. A similar schedule is kept of all casting purchase orders. This schedule is handled in exactly the

same way as described above for purchase orders. All urgers, however, for casting purchase orders are made out in the form of a list and handed to the production clerk, who personally urges the casting past due.

The importance and value of a schedule as a means to insure prompt delivery of material cannot be overestimated. It is one boy's duty to keep these two schedules referred to, and it is practically impossible for material to be delayed without the matter being continually brought to the attention of either the purchasing agent or the production clerk. These schedules also show material that has been invoiced, so that if an article is due to-day and has not been received, a glance at the schedule will show whether it has been invoiced or not. The use of these schedules has reduced the annoyance due to delayed material to a minimum. Aside from this, they give an exact history of the transaction from beginning to end, and form a very handy reference in planning work ahead, as a glance at the schedule will show whether the material has arrived in the shop, or if not, when it is due. Promises made on material past due are also noted on the schedule. All work in process is scheduled in a similar manner, but on the schedule cost sheet (see Plates VII and VIII), which is in charge of the cost clerk, as above described. This cost sheet will be taken up as a separate feature in connection with the fifth chapter under 5-D.

3-N. The Factory Mail System

The factory mail system is one of the first features to be installed in connection with the new form of management. The plan employed is to have a box at each man's desk or table, both in the office and shops. The box is about 8 ins. wide by 4 ins. deep by 4 ins. or 5 ins. high, with a partition in the middle. One side is marked "In" and the other side "Out," and each box is numbered. All papers, memoranda, etc., are put in the "Out" side of the box, and

the mail boy in making his rounds leaves whatever matter may be marked for that particular box, in the "In" side, and takes out that in the "Out" side, to be left at its destination on that trip or the succeeding one. The mail boy has a light case with loose fiber-board compartments, each compartment being marked to correspond with a number on a mail box. The Ferracute Machine Co.'s boy starts at the planning department and passes from the drafting room through the office departments and out through the shop departments, taking and leaving mail at each box on the route. This particular route consists of twenty-seven stations and is run on a fifteen-minute schedule, which is the fastest service of this kind I know of. The round trip actually takes about eight minutes, and the boy is provided with a chair in the planning department where he rests the remaining seven minutes. His first trip commences at 7 A.M. and the last trip in the morning at 11.45 A.M. The first afternoon trip commences at 1 P.M., and the last trip at 5.45 P.M.

The efficiency of a modern system of management depends considerably on the promptness of the mail service, as all papers, letters and other documents are transported almost exclusively by this means, except the drawings, which are handled by a special drawing messenger service. It is hard to compute the amount of time saved by means of this mail service, but the result is a minimum of errand work on the part of the different office people and department heads. A memorandum scratched on an ordinary piece of paper, marked with the box number of the person to whom it is addressed and placed in the mail box, will, on the average, be delivered within fifteen minutes, which is sufficiently prompt for ninety-nine per cent of the inter-department communications. Apprentice boys applying for admission to the shop are put on this mail service, when possible, for four months, preparatory to taking up their apprenticeship. This has the particular advantage of giving them a taste of discipline, while teaching them

more or less of the routine of the shop, and it brings them in touch with the different department heads. It is a good preliminary experience preparatory to taking up shop work.

Referring to the illustration of the statistical side of the planning department, Fig. 7, the mail boy may be seen at the right-hand side of the photograph with his case on the table beside him, waiting for the time to start on his next trip. Under no circumstances is the mail boy called upon or allowed to perform any other duties than those specified in his instructions in connection with the factory mail system. This is a most important point to insist upon, as the clock-like precision of the service would be impossible if he could be called upon to do any other work or errands. In point of fact, the system results in restricting practically all errand work to the factory mail system. This is another functional position, which, though a small one, is by no means of the least importance. In the majority of businesses it is a common thing for department heads, office people, and others to be continually doing errands that take a lot of time. It also tends to cultivate the habit of gossip on affairs foreign to the work for which these people are paid.

3-O. The Time Boy

The time boy is an assistant to the time clerk, and his chief duties consist of making out the job cards for the men daily and distributing them to the various foremen and gang bosses. These job time cards are turned in at night and the first thing the next morning are gone over by the time boy, who stamps on each coupon the date, as well as the department in which the man is employed. He then transposes each work number, which appears on each coupon of each time card, to the job number to which that particular work number applies. The third copy of the next-work order made out by the route clerk and filed in the numerical file referred to above, forms a reference

to enable the time boy to properly transpose these figures. Work numbers run from 1 to 99,999 inclusive, and then repeat. In the photograph of the controlling section of the planning department, Fig. 6, the time boy can be seen working at this file.

3-P. Duties of the Inspector

Proper inspection is essential in any shop under any form of management, but like many other "essentials" is conspicuous by its absence in the majority of plants. I know that this statement is very likely to be criticized by many who *think* they have an efficient system of inspection; but it is oftentimes a farce. Proper inspection is impossible without:

1. A proper purchasing system;
2. A proper system of stores;
3. A proper system of costs;
4. A proper system of routing;
5. A proper system of drawings;
6. A proper system for orders and shipping; and
7. A proper control of methods.

The first requisite of an inspector is the possession of a sound and fair judgment. He must recognize no favorites and must refuse to pass work not up to specifications and drawings. He must be able to grasp the importance of various parts as compared to the whole; to discriminate between different classes and qualities of work as well as to look out for incorrect drawings. These may cause unnecessary expense due to too small limits of variation, too good or too poor finish. Long delay and a considerable monetary loss may result from an error in machining which might be compensated for in another piece, but without proper inspection would not be known in time to remedy.

The inspector is distinctly a functional foreman and a representative of the planning department, and in his special capacity is over every man in the shops. His word

is final and his decision can be set aside by the superintendent only. When the superintendent cannot uphold the decisions of the inspector, it is time then, and then only, to get a new inspector.

Rough material, such as castings and forgings, must be surveyed to be sure that they will finish to drawing. Castings, particularly those of intricate design, must be carefully inspected to see that they are true to pattern, that cored holes are correct, and that sufficient (but not too much) finish has been allowed. Detrimental shrink cracks, and shrink, dirt or blow holes must be carefully looked for. No castings should be accepted that have been painted, filled, caulked, or otherwise patched or treated. If this is allowed, a casting that will fail in service might have many dollars' worth of labor expended on it, which could otherwise have been saved. The foundry is not in position to know whether an apparently slight defect is a serious one or not. Forgings and like material must be examined as soon as received to see that detrimental piping or seams do not exist and to be sure that the pieces will finish to drawings. All material is passed upon by the inspector before it is formally received by the receiving clerk, who checks his copy of the purchase order and delivers the material to its destination.

Parts in process are inspected after each operation and before they are moved to the next machine, bench or other department. When more than one piece is called for on a work order, the inspector is required to pass upon the first one as soon as the operation specified is completed. The first piece must be made correctly before the workman is allowed to proceed with the balance of the lot. This feature is most important and often saves considerable loss. Whenever possible, the inspector is at hand during the machining (or other operation) of the first piece. When a piece is condemned or cannot be passed except as a variation from specification and drawing, a condemnation slip is made out by the inspector. This condemnation slip, Fig. 8,

reports all the facts necessary to enable the superintendent, through the planning department, to make proper disposition of the piece, get out a replacement part when necessary, locate the blame, and take means to prevent a recurrence of the error. The condemnation slip is used for incoming material, work in process, or work ready for shipment.

The inspector has a complete set of typewritten instructions as a guide to assist in the proper inspection of the

INSPECTORS CONDEMNATION REPORT Form F. A. P.-47a FERRACUTE MACH. CO.

Date ---- 19 ---- Time ---- A. M. P. M.

SUPERINTENDENT—I cannot pass the following work for reasons stated below, the one responsible being ---- No. ----

DRAWING, SKETCH ---- QUANTITY ----

WORK NO. ---- PIECE ----

REMARKS ----

Signed ----
INSPECTOR.

NOTED, SEE OTHER SIDE, ----
SUPT.

FIG. 8.—Inspectors condemnation report.

particular kind of work under consideration. A ready-made inspector is always hard to find, but especially so in some lines of business. A proper man has to be found from among the employees and carefully trained for the position.

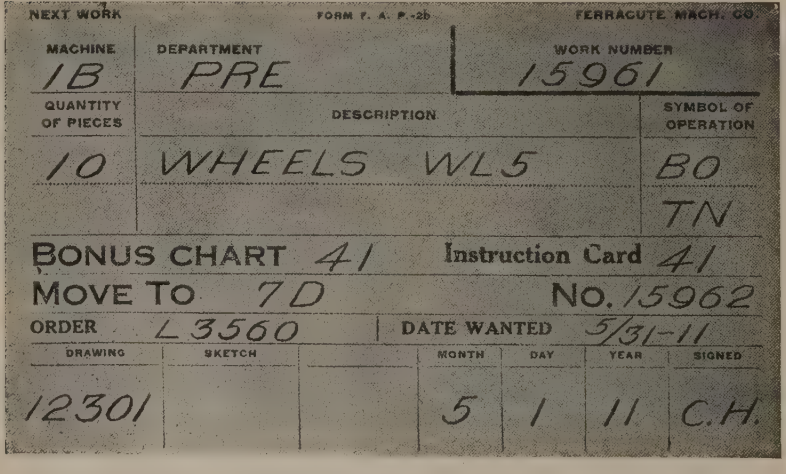
3-Q. THE STORES KEEPER

The stores keeper is responsible for the care of all stock, including proper piling of it in the bins or on the shelves and the proper receipt and issuance of the stock to and from the store room. He is allowed to issue nothing without a properly signed material card, showing to what the

material required is to be charged. When issuing any kind of stock he is responsible for the proper wording on the card so that it agrees with the known way of recording it in the planning department. This reduces to a minimum the chances of error on the part of the stores clerk in charging to or from the stores card. The fifth chapter will treat more fully of the subject of stores under 5-A.

3-R. The Move Material Boss

The move material boss occupies another purely functional position. He has one or more assistants, according to the kind of plant and the volume of work to be handled.


NEXT WORK — FORM F. A. P.-2b — FERRACUTE MACH. CO.

MACHINE	DEPARTMENT	WORK NUMBER
1B	PRE	15961

QUANTITY OF PIECES	DESCRIPTION	SYMBOL OF OPERATION
10	WHEELS WL5	BO
		TN

BONUS CHART 41 Instruction Card 41

MOVE TO 7D NO. 15962

ORDER L3560 DATE WANTED 5/31-11

DRAWING	SKETCH		MONTH	DAY	YEAR	SIGNED
12301			5	1	11	C.H.

Fig. 9.—Next work order.

Nothing whatever is moved from one department to another, to or from a machine except by a written order. The next-work order (Fig. 9) shows the destination of the material called for. These next-work orders are passed to the material boss by the gang boss or foreman as soon as each is through with the piece in question. The move material boss then moves them immediately to the next destination. This saves all waste time on the part of the

bosses or men in looking up the next job for the different machines or men. Further than this, it concentrates the moving of all material to one or two men employed solely for this purpose. As soon as the material has been moved, the move material boss takes the next-work order for the operation to be performed by the machine just receiving the work and moves it from the bottom compartment in the shop rack, up into the middle one, putting it behind those already there. The first next-work order is then mailed to the planning department, and then the second-work order is moved up to the middle compartment so that it agrees with the shop rack.

In the Ferracute Machine Co.'s shop it has been considered by the superintendent that at a most conservative estimate this one feature alone has resulted in saving at least half an hour per day per man employed in the main machine shop. The fourth chapter will take up the functions of the move material boss under 4-C.

The work of training men to competently fill the positions described above is one of the most important duties of the organizing engineer. No doubt many managers are in sympathy with the methods of scientific management, but feel that the difficulties of its installation are prohibitive. This is an erroneous idea, as every firm of any size has plenty of good material available, which the organizer is specially fitted to develop.

CHAPTER IV

4-A. The Routing of Work through the Shops
4-B. Symbols
4-C. The Functions of the Material Boss
4-D. The Functions of the Order-of-Work Clerk
4-E. Gang Bosses
4-F. Speed Boss

Careful and systematic routing of all work is an unknown factor in the ordinary shop, and where a clearly defined course for each piece or lot of pieces in their progress through the various departments does not exist, confusion must reign and result in delays. These delays are particularly noticeable in a shop running at its maximum capacity. Parts are misplaced, side-tracked, and finally forgotten or overlooked, sometimes, for weeks. Suddenly, when work is partly assembled, the discovery is made that this, that or the other piece is missing. Then ensues a general hunt, successful or otherwise, to locate and rush through to completion the required parts to finish the order according to specification. Work already in some of the machines must be stopped, and sometimes hours or even days of labor which have been spent in preparation of the machine and job thus broken up are thrown away to make room for the tardy parts. Eventually work will be resumed on the job so broken up, with the result that the preparation must be done all over again. Large work is sometimes interfered with in this way several times before it is finally finished ready for erection.

A shop of any size will have hundreds or thousands of different pieces in process at one time, and it is futile to attempt economy in manufacture or expect to realize plant efficiency without a complete and carefully laid-

out system of routing. The common forms of management "put it up to the foreman" to see that work goes through the proper channel to be finished in time. This is one of many other responsibilities commonly shifted to the shoulders of the shop bosses, men who are already loaded down with a variety of annoyances and duties that should be removed or assumed by other specially trained men. It is evident that a shop boss is not in position to know of the relative importance of all work on order. He cannot devote the time to planning for its machining, even if he does know which part to do first. He cannot tell what work has been quoted on and which may be ordered at any moment. In a word, the efficient routing of a shop's entire product cannot be *part* of any one man's job, but must be the sole function of one or several men. This man's duties necessitate his being in close touch with orders, stores, shop engineer and others in the planning department, so that he makes this department his headquarters. Closely associated with him is the material boss and the order-of-work clerk, as well as the gang bosses in the shops. These several men each have to do with the efficient handling of material and work in process. Below will be found the detailed description of what is involved.

4-A. The Routing of Work through the Shops

The first step to be taken when preparing to install a system of routing is to chart the different departments and machines and also the work benches. After this has been done the entire layout must be carefully studied to determine the best arrangement for all equipment. This brings up for consideration the kinds of product being handled and a study of their course through each department.

The machines should be grouped by classes and according to size as much possible, and in such order that the movement of work in process through each department

is an uninterrupted course. Retrogression must be avoided. Much rearrangement of machinery is often necessary to give the best results. The local conditions, expense involved and other considerations all have their influence on the problem. It is often desirable to make a change of this nature gradually so as to distribute the expense over a greater period. Again, the condition of business often necessitates postponement owing to the time that the changes contemplated will take. Whether these changes are made complete and at once, or slowly, should not affect the final arrangement. It must conform to the ideal as first worked out and charted. The entire equipment must also be on record, as will be explained in a later chapter, so that the route clerk can intelligently route work to the best advantage.

The route clerk must be a man of good judgment and one thoroughly familiar with the best machine shop practice, if the work is mostly of this nature. If the plant is a large one, then several route clerks may be necessary, each one being responsible for his particular departmental work and thoroughly conversant with the various branches of the trade involved. For example, the qualifications of a route clerk for a large foundry business will differ from those of a route clerk for a large wood-working shop, and so on. The number of men employed also regulates the number of route clerks, although a small shop can be handled with one chief route clerk and one or two boy assistants. The kind of business also influences the number of route clerks.

It can be readily understood how a specially trained functional man of the kind described can more intelligently and efficiently direct the course of many parts through the works than can foremen and gang bosses burdened with other duties. In the latter case each one would have his own pet way of doing things. Standards and team work would not be known.

After the material list (Fig. 5) has been checked off

against the stores ledger and the material not in stock or in process has been ordered by the production clerk, the material list is passed to the chief route clerk. His first step is to collect the drawings of the various pieces he is to route. Eventually each drawing will have the standard routing indicated in the place provided in the label. See Fig. 4. It is the chief route clerk's duty to see that work orders are issued to the several departments covering each separate operation on each piece. He may choose to issue these personally or he may fill out the proper routing across the top of the schedule cost sheet and have the necessary work orders made out by one of his lower-paid assistants. These assistants are boys getting four or five dollars per week. Repeat work after once being standardized is routed by them exclusively, using the last previous schedule cost sheet (plates VII and VIII) as a guide. The cost of routing is thus reduced to a minimum. In the case last referred to, the boys originate both the headings for the schedule cost sheet and the next-work orders, Fig. 9.

The standard routing on the detail drawing indicates the machine symbol of the machine best adapted to do each successive operation as previously determined by the shop engineer. This routing need not be strictly adhered to as far as actually doing the work in the machine indicated, if the machines specified are already well provided with work and there be others of the same type and size available. The idea is to record the size and type of machine to insure maintaining the standard method. If the piece be a new or intricate one and the routing is not specified on the drawing, the chief route clerk proceeds to route the work according to the best combined judgment of himself and the shop engineer. At all other times he uses his own judgment.

Work orders, size 3×5 ins., are made out in triplicate, as already explained in a previous chapter. One of four different work orders may be used, depending on the importance of the work in question, as follows:

1. A yellow form printed in black.
2. A yellow form printed in red.
3. A red form printed in black.
4. A red form printed in red.

} See Fig. 9.

All work which is to take an ordinary course through the shops is routed on form 1 (yellow and black). If a piece is to have the preference over the regular work, the second form (yellow and red) is used. All work which is to be rushed through as an emergency order is routed on form 3 (red and black). Whenever this form appears, it is the only notice necessary to inform the gang boss or foreman that work ahead of it is to be immediately broken

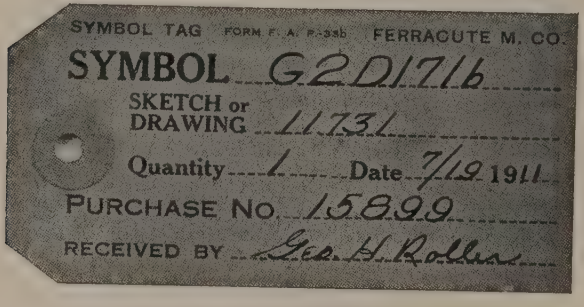
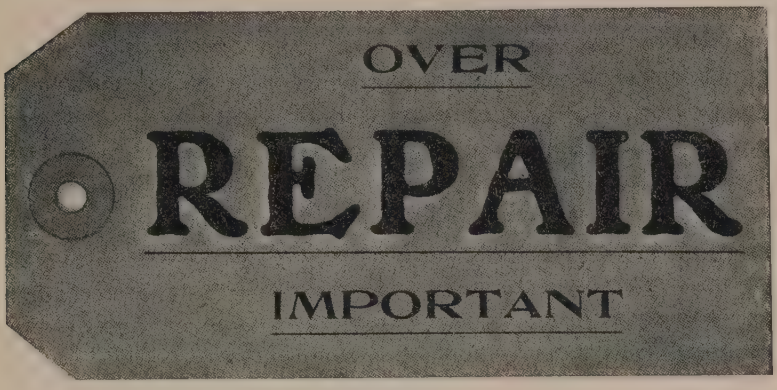

SYMBOL TAG FORM F. A. F.-335 FERRACUTE M. CO.
SYMBOL G2D1716
SKETCH or DRAWING 11731
Quantity 1 Date 7/19 1911
PURCHASE NO. 15899
RECEIVED BY Geo. H. Rollins

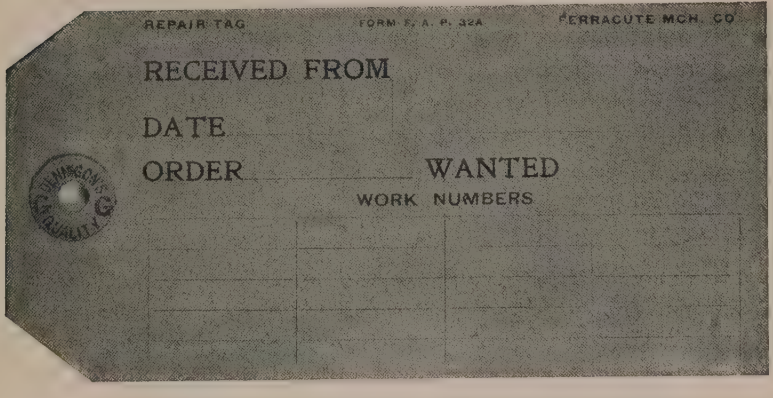
FIG. 10.—Symbol tag, which is attached to all work in process.

up and side-tracked in favor of the red-black form. The time used in dismantling a machine or job must always be charged to the third form work number necessitating the change. The time necessary to reinstate the job broken up, up to its condition at the time of the break-up, is also charged to the third form work number. This third form work order does not however authorize any overtime. The fourth form work order, red and red, commonly known as a "red rush order," is authority for the gang boss or foreman to instantly break up the job then under way, and to keep the red rush order job going day and night until it is finished. Nothing must be allowed to interfere with its progress, and it is not supposed to stop from the

time the material arrives in the shop until the finished piece or job is completed and shipped. The break-up time and rigging up of the previous job is charged the same as explained above for the " third form " order.



Back.



Front.

FIG. 11.—Repair tag, which is attached to all parts returned for any purpose.

Much depends on the judgment of the chief route clerk in the handling of these various next-work forms. Their use must not be abused or they would soon be of little value. The intelligent rearrangement of the next-work orders in

the route rack by the order-of-work clerk makes the use of any but the first form order rarely necessary, so that when the others are used they become most effective. Fig. 9 shows a next-work order filled out; the wording and ruling of each of the four forms is alike, the color combination being all that is required to get results. The destination of the piece is shown for the use of the material boss, as will be explained later, this next-work order acting as a move order as well as a work order. The symbol tag shown in Fig. 10 is attached to all work in process. Fig. 11 shows the repair tag which is attached to parts returned for alterations, repairs or replacements.

Another form of work order provides for the record of the starting and stopping time, so as to have the one form do for both routing, moving and time check. This form was not adopted at Bridgeton, as it was desirable to have all time return posted to the cost sheets daily, and as much of the work is of long duration, the present method was adopted.

All work must be routed so as to distribute it as evenly as possible to all the machines in commission. This avoids congestion, brings a maximum amount of equipment into use, resulting in the faster movement of work to completion.

4-B. Symbols

The use of department, operation and other symbols is necessary to the efficient routing of work by reducing the amount of writing and the space required. It would be a hopeless task to write out in long hand all the documents used in connection with modern management. Symbols must be used on:

1. Drawings.
2. Material Lists.
3. Store Cards.
4. Next-work Orders.

5. Time Cards.
6. Cost Sheets.
7. Time Studies.
8. Instruction Cards.

In fact, their use becomes imperative on nearly all forms if clerical work is to be handled expeditiously and cheaply. The mnemonic symbol system has been in process of development for many years, but its practical adoption for piece symbols has not yet been realized. Certain sets of symbols for a limited number of parts and for a largely standard line of pieces can undoubtedly be developed mnemonically. If, however, the scheme is attempted on any extensive scale, it becomes cumbersome and top-heavy and fails because of its own weight. It is often necessary under the mnemonic system to have symbols of twelve, fourteen or even more characters. They are hard to read, harder to write, and although nearly theoretically perfect, are a nuisance in practice. The author has been in contention on this subject, as far as piece symbols are concerned, for some years. A symbol is after all nothing but an identification mark.

One form of an arbitrary piece symbol is a numeral followed by the letter X. The letter X is chosen because it is unlike any figure, is easy to make, and does not happen to be the characteristic letter of any other kind of symbol. All pieces are to be symbolized without regard to whether they are made or purchased. All pieces are to have the same kind of symbol (a numeral followed by the letter X) even though special and never to be used more than once. All commercial articles such as standard bolts, screws, nuts, cotters, taper pins, keys, wrenches, oil cups, washers, etc., should be symbolized first, commencing at 1X. This should be systematically done and a symbol provided for each kind and size of each different article as listed in the maker's catalogs, regardless of whether it happens to be in use at the time or not; it may be used later.

The parts made by the firm should next be symbolized, taking for the first piece the next unused number. This should also be systematically done by taking parts in the alphabetical order of their names and also in the order of their sizes. For example, if the first machine is "A" type, all "A" parts should be symbolized first; if the "A" type consisted of, say, six sizes, the first size piece (alphabetically) would be symbolized first and the other five sizes of this piece would take the next five consecutive numbers. After taking all pieces of all sizes in the "A" type, the next type ("B" for example) would be treated likewise, and so on through all the different types and sizes.

New parts should be symbolized in the order of their coming into use and arbitrarily. If a piece is to be made by an alteration to a pattern already in existence, say 1120X, the new piece made from this altered pattern would be known as 1120X1. The addition of the numeral after the X is to show that the pattern 1120X was altered and indicates at once that a wholly new pattern is not required. If the pattern has some other alteration or addition later for another piece, the new piece would be known as 1120X2. Should a casting be finished differently than the standard 1120X, the only change being in the machining of it, it would be symbolized as 1120XA, the additional *letter* indicating a change only in the finishing, as well as to show what standard rough part can be used. A bolt blank may be known as 621X; if threaded, say three and one-half inches, it would then be 621XA; if the same blank could be used for a bolt faced under the head or otherwise different from the above, it would be 621XB. It is not likely that any one part would be machined more than twenty-six different ways.

The piece symbol index is a double one, one set of cards being arranged numerically from 1X up, the other alphabetically, as follows:

ARMS
- A type
  - 1 size
  - 2 "
  - 3 "
  - 4 "
  - 5 "
  - 6 "
- B type
  - 1 size
  - 2 "
  - 3 "
  - 4 "
  - 5 "
  - 6 "
- C type
  - 1 size
  - 2 "
  - 3 "
  - 4 "
  - 5 "
  - 6 "

The above scheme is outlined as descriptive of a method that has worked admirably in practice. The combination of numbers and letters can be arranged in several ways. The suffixes shown have also worked very successfully in practice combined with a modification of the mnemonic symbol system.

The grouping scheme of symbol described below which has been adopted in place of the mnemonic system for piece symbols is one of the most practicable that has yet been devised. Practical experience with many forms of piece symbolizing in different lines of manufacture has proved, many times, that a class or group letter or letters, combined with arbitrary numbers (these numbers can of course be systematically and logically arranged), is the ideal form of piece symbol. Ten or more years ago a development of this scheme was worked out under the author's supervision in connection with a number of different classes of machines. The class letter was used, followed by

a number. Every piece of each different machine was symbolized, starting with the most important pieces, following out when possible the order in which they should be assembled. Later, if a piece was added, it took the next unused number in its class. An E class piece, say E112, might also be used in an S type machine, in which case the bill of material (although mostly of "S" parts) would have in its proper alphabetical and numerical position the piece with its symbol E112. Of course, no piece has more than one symbol, nor does one symbol apply to more than one piece. A convenient grouping for a few general classes has been used to advantage somewhat as follows: B1 and upward arbitrarily, for boiler parts, M1 and upward for marine parts, and X1 and upward for transient and miscellaneous pieces. This plan was improved upon by grouping parts, using suggestive letters (generally two) after the letter X. The X indicated that the symbol applied only to a piece. The following list illustrates a method of grouping for attachments parts:

XAC. Scrap clipping attachment, parts for
XAD. Dial feed " "
XAE. Embossing " "
XAF. Finger gage " "
XAK. Knockout " "
XAL. Reel feed " "
XAM. Motor or drive " "
XAP. Push out or feed " "
XAS. Spring drawing " "
XAR. Roll feed " "
XAN. Notching " "
XAU. Unclassified or miscellaneous attachment parts

In studying over the above, it was decided to omit the letter X as it seemed superfluous, in view of the fact that a symbol of two letters followed by a numeral would not in any way conflict with other series of symbols. The

result was a compromise between the purely arbitrary number symbol and the strictly mnemonic symbol, resulting in two suggestive group letters followed by a numeral. Under this method a shaft would have a number in the SH group, as SH12, or a wheel (in the WL group) WL5.

Department and operation symbols are also necessary and the latter are of particular importance. A letter to indicate a department and a number to indicate the operation is one of the means employed. A number symbol for an operation is much harder to remember, however, than are suggestive two-letter symbols, such as are listed below. Past experience determined the author to adopt the two-letter operation symbol for the future, especially as it does not conflict with the other sets of symbols, both for departments and operations. This is the plan followed out at Bridgeton, and below will be found some of the department and operation symbols in use by the Ferracute Machine Co. These have been in successful operation over four years; they are easily learned and as easily remembered.

Department Symbols

ACC. Accounting
ASM. Assembling
CAR. Carpenter
CLE. Cleaning
COR. Correspondence
COS. Cost
DIE. Die
ENG. Engineering
FIL. Filing
FOR. Forging
PAI. Painting
PAT. Pattern
PHO. Photograph
PLA. Planning
POW. Power
PRE. Press
PRO. Production
REC. Receiving
ROU. Routing
SHI. Shipping
STO. Stores
TOO. Tool

Operation Symbols

AP. Alter Pattern
AN. Anneal
AV. Approve
AS. Assemble
BT. Babbitt
BA. Balance
BV. Bevel
BO. Bore
BX. Box
BZ. Braze
BU. Bush
CA. Cancel
CH. Case Harden
CE. Center
CD. Checked
CP. Chip
CK. Chuck
CL. Clean
CN. Condemn
CB. Counterbore
CS. Countersink
CR. Crate
CO. Cut off
CT. Cut teeth
DF. Defective
DE. Design
DM. Dismantle
DN. Done
DP. Don't Proceed
DW. Draw
DS. Dress
DL. Drill
XP. Experiment
FA. Face
FI. File
FL. Fill
FH. Finish
FT. Fit
FU. Fit up
FO. Forge
GR. Grind
HD. Harden
IT. Inspect
IL. Install
IS. In Stock
IN. Invoice
JG. Jig
KE. Key
KS. Key Seat
LR. Leather
LO. Lay Out
LC. List Complete
LP. List Partial
LD. Load
MP. Material Provided
MM. Moved to Machine
ML. Mill
MI. Miscellaneous
MD. Mold
MO. Moved
NY. Notified
OG. Oil Groove
OR. Ordered
OH. Overhaul
PA. Paint
PN. Pattern Maker
PH. Photograph
PL. Plane
PO. Polish
PU. Punch

OPERATION SYMBOLS—*Continued*

PS. Purchase
RM. Ream
RE. Receive
RP. Replace
RN. Requisition
RO. Resume Operation
RT. Rivet
RU. Routed
RD. Rub Down
SC. Scrap
SS. Set Screw
SE. Setting
SU. Set Up
SH. Ship
SK. Shrink
ST. Slit
SL. Slot
SD. Solder
SP. Spherical
TD. Take Down
TO. Take Out
TP. Tap
TE. Temper
TT. Test
TH. Thread
TR. Trace
TN. Turn
UD. Unload
UR. Urge
WT. Want
WL. Weld
WD. Wind

Each machine, vise, etc., is also symbolized. A common form of machine tool symbol is the initial letter of the name of the machine preceded or followed by a numeral. The author can see no particular object (except to clear other existing sets of symbols) in putting the numeral before the letter, rather than after it, or *vice versa*. It is surely more correct to say lathe 5 (symbol L5) than to say 5 lathe (symbol 5L). Both methods are in extensive use and answer the purpose. Arbitrary numbers for machines systematically arranged, answer every purpose, as they also do for piece symbols.

Machine and other tools are ordinarily grouped as follows:

B. Boring machines.
D. Drill presses.
G. Grinders.
K. Keyseaters.
L. Lathes.

M. Millers and gear cutters.
P. Planers.
S. Shapers and slotters.
V. Vises.
W. Woodworking machines.

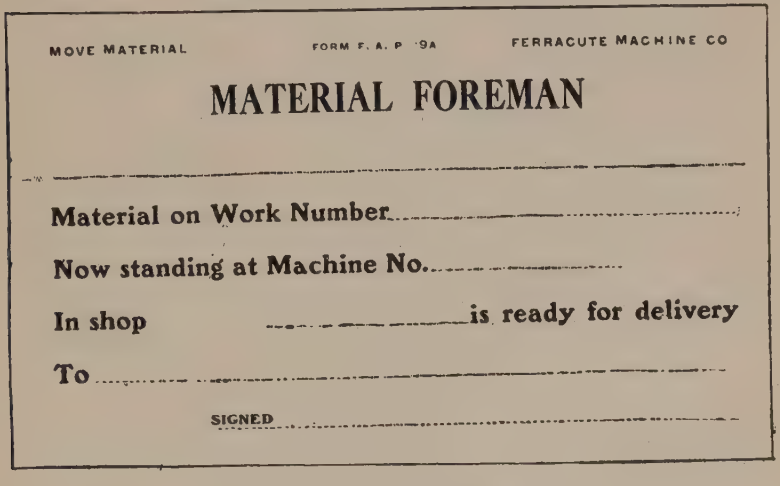
The symbols for tools, such as are used on lathes, planers, boring and drilling machines, slotters, shapers, etc., not including standard commercial drills, taps and reamers, consist of the letter " T " followed by a number; as T21, T30, and so on. A symbol cannot be wholly and practically suggestive without being too cumbersome; after all, it is nothing but an identification mark. We have no trouble in locating drawing 12231, neither do we have any trouble to get the correct tool, which we know is T23. Then why should we not as easily locate and identify the right piece. the symbol of which may be X3146 or WL29?

The author hopes to be able in the near future to publish a complete treatise covering all classes of symbols necessary to a manufacturing or jobbing business.

4-C. Functions of the Material Boss

All material is moved from machine to machine and between departments by the material boss. Most of this moving is done in accordance with the routing specified on the next-work order (see Fig. 9). Material is moved out of stores on a " Move Material " form shown in Fig. 12, there being no work order issued for the initial movement, although there may be one for the work to be done, if any, on a piece after it reaches its destination. When material is moved on a work order, the work order for the succeeding operation is moved from the bottom compartment of the shop rack to the middle one, by the move material boss. The work order authorizing the move is then signed by the move material boss and forwarded to the planning department, where the work order for the next operation

is moved up in the planning department rack to conform to the shop racks. These orders are always put in the back of the compartment, although they may be later changed by the order-of-work clerk so as to bring the order of work at the machine into the desired sequence. As previously explained, the purchase orders and casting purchase orders (see Plates I and II) indicate the destination of all incoming material, and they constitute the


MOVE MATERIAL FORM F. A. P. 9A FERRACUTE MACHINE CO

MATERIAL FOREMAN

Material on Work Number.....

Now standing at Machine No.....

In shop .....is ready for delivery

To .....

SIGNED .....

FIG. 12.—Move material form.

move order in such cases. The result of these methods is the automatic movement of material from the time it starts in process until it reaches its final destination. No one is allowed to move material except the material boss, and he only does so on order as above indicated, and then always to a predetermined location. This is essential to the maintenance of a correct route sheet, as will be explained in connection with the schedule cost (plates VII and VIII) sheet in Chapter V under 5-D.

4-D. The Functions of the Order-of-Work Clerk

As his title indicates, the sole duty of the order-of-work clerk is to follow in detail the course of work in the shops. Being in continual touch with the superintendent and production clerk, he is always informed as to the relative importance of each and every job under way. He is also a member of the Factory Board, and keeps his records in accordance with the work as it is planned several weeks ahead at these meetings.

All press orders as soon as received are listed on the Press Schedule, as shown in Fig. 13. From this schedule job numbers are allotted, the preliminary operations are worked out and specially followed up by the superintendent and production clerk. The press schedule is consulted daily during the Factory Board Meetings in connection with the general planning done by the members on all unfinished work. The breaks in the heavy vertical black line show graphically the unfinished machines. The length of the heavy horizontal black line indicates at a glance the condition of the preliminary work for which the drawing room, planning department, pattern shop, and foundry are responsible. Further detail is worked out later by the order-of-work clerk from the general route sheets (Plate V) and schedule cost sheets (Plates VII and VIII). At the right of each item on the press schedule (Fig. 13), in the proper month column, the promised date of shipment is marked in red ink. When shipment is made, the shipping date is marked in black ink and the heavy vertical line at the left is ruled opposite the item referred to. As the delivery dates of the work in process draw near, the order-of-work clerk carefully studies the schedule cost sheets, from which he makes out a "shortage" list, showing parts not yet finished. It is necessary that this work be done well in advance, so as to prevent parts needed from getting very far behind the schedule. The order-of-work clerk is responsible for the finishing on time of all work

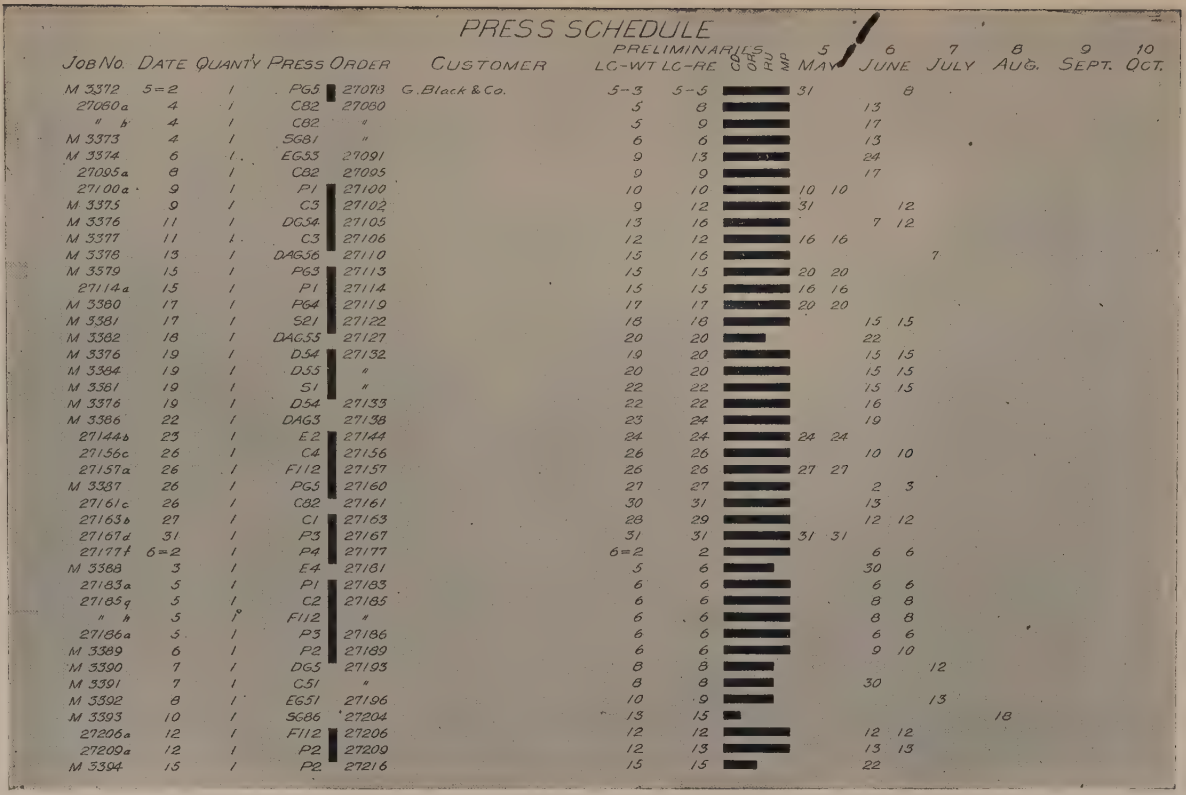


FIG. 13.—Press schedule. A graphical record showing the general condition of each machine order.

in process; if delays are occurring, such as non-arrival of material, he follows up the production clerk until the material is received. If the delay is again beyond his control, due to equipment out of commission, or to a similar cause, he refers it to either the superintendent or shop engineer. Otherwise it is up to him to continually rearrange the order of the next work forms in the route rack so that pieces are brought through on their proper order. Material received on purchase orders and casting purchase orders, and on which the first operation is machining, is controlled from the production department on the arrival there of the receiving clerk's blue copy of the purchase order. These purchase orders are passed immediately to the order-of-work clerk who has the first work orders moved at once to the middle compartment in the planning department route rack (Plate VI), thus showing the arrival of the material at the machine. At times congestion of work at a machine makes it necessary to re-route some pieces; in such cases, he confers with the chief route clerk and has the necessary changes made to enable him to move the work.

A red signal card is put in the top compartment in the planning department route rack of each machine not in operation. This rack is checked up every morning and every afternoon, immediately after starting time by the order-of-work clerk. If there is no work for the machine to do, the condition of the rack shows it by the absence of next-work order forms in either the middle or top compartment. A red signal card in a machine compartment with work orders in the middle compartment, but none in the top compartment, indicates that the machine is without an operator and that no work is set in it. If there is a work order in the top compartment behind the red signal card, it indicates that the machine is without an operator and the job specified on the said work order is standing idle in the machine. If the red signal card in any of the above cases displays a large letter R it indicates that the machine

is undergoing repairs and cannot yet be operated. The absence of a red signal card indicates that the machine is running. Plate VI shows the planning department route rack in illustration of some of the foregoing details. A glance at the rack will show the entire plan of work in process, that under way and ready for each machine, and what work has not yet arrived. It takes but a moment to tell what machines are out of repair, without operators, or shut down for want of work.

A list is made out every Monday for the use of the members of the Factory Board. This list contains a record of all uncompleted machines on order up to and including the previous Saturday night, as per the press schedule, and includes:

a. Date of order.
b. Quantity.
c. Machine symbol.
d. Customer's name.
e. Date on which it is to be shipped.

From this list, general route sheets (Plate V) are made, showing the most important parts required to fill the order due for shipment or completion within the next four or five weeks, such as frames, gears, shafts, rams, beds, columns, etc. Beside each item are listed the operations to be performed, and the date such operations should be completed. From these route sheets all important parts are continually followed up. The time required for each operation and the date for completion of the finished machine is worked out in connection with these sheets.

The control maintained over foundry orders (and hence casting deliveries), due to careful and systematic planning, combined with anticipating requirements as much as possible, makes it a comparatively easy matter to fix the RE date on the general route sheets. The succeeding operations are then figured out, based on the average time required for each operation, as shown by the records, plus

a small allowance for contingencies. It will be seen by referring to Plate V, that all machines are listed on these route sheets in alphabetical and numerical order. Reading from left to right opposite any piece will be found the dates on which each machine (indicated at the top of the vertical column) is to finish its work on that piece. Reading vertically in each machine column will show the number of different pieces on which that machine has to work, as well as the dates that it will be busy and therefore not available for other work. The order-of-work clerk in manipulating the next-work orders in the route rack can continuously work in pieces for later delivery than those specified on the general route sheet, if there are dates available and material is at hand. Smaller and more standard parts, if not already in stores, are usually made on stock jobs and are followed up direct from the schedule cost sheet, Plates VII and VIII. Every morning the board members check over the unshipped order list, crossing off the machines that have been shipped the previous day. A new list being made every week, all items on order are repeatedly brought before the members and they can be followed from the start. If the design, drawing, checking, routing, ordering and pattern work can be done promptly and the material received in the shop, the rest is straight-ahead work and delivery dates, although comparatively short, can be maintained.

The information from the drawing room, chiefly in form of material lists and detail blue-print drawings, is considered an operation and followed up as such. So is the work incident to the routing in the planning department. Definite dates for the completion of this part of the work are just as important as some of the later shop operations, in fact, more so. If the work is not promptly designed, drawn and routed, and the material under way, the whole job is delayed and thrown off schedule. A late delivery will then result. Too much stress cannot be aid on the importance of prompt and strenuous attention

being given to the above-mentioned preliminaries. As previously explained, this part of the work is specially delegated to the superintendent.

4-E. Gang Bosses

Each manufacturing department is in charge of one foreman who generally has under him one or more gang bosses. Each of these men is directly responsible for his own particular gang and is a working boss; he assists the men of his gang in the performance of their work in various ways.

1. He must see that each man has at least one job ready for him besides the one on which he is at work.
2. He must provide and have ready the necessary drawing, tools, jigs, etc., to enable the workman to do the job efficiently and according to instructions.
3. He must assist a man when necessary or instruct him in the performance of his task, according to the instruction cards.
4. He has authority, subject to the approval of his foreman, to lay off or discharge any of his men, or otherwise discipline them.
5. He must maintain his equipment in good working order (by report to his foreman) and is responsible for the abuse of any company property in his charge.
6. Time charges to each job must be approved and signed by him.
7. He must enforce the shop rules.

No gang boss should have more than fifteen men under him, and best results will be obtained if the number does not exceed ten.

An ideal arrangement for a gang boss or foreman's desk or table is that shown in Fig. 14. The raised platform is six or more feet above the shop floor. The racks for work orders are placed thereon, as well as the inter-department telephone. Whenever the gang boss has occasion to

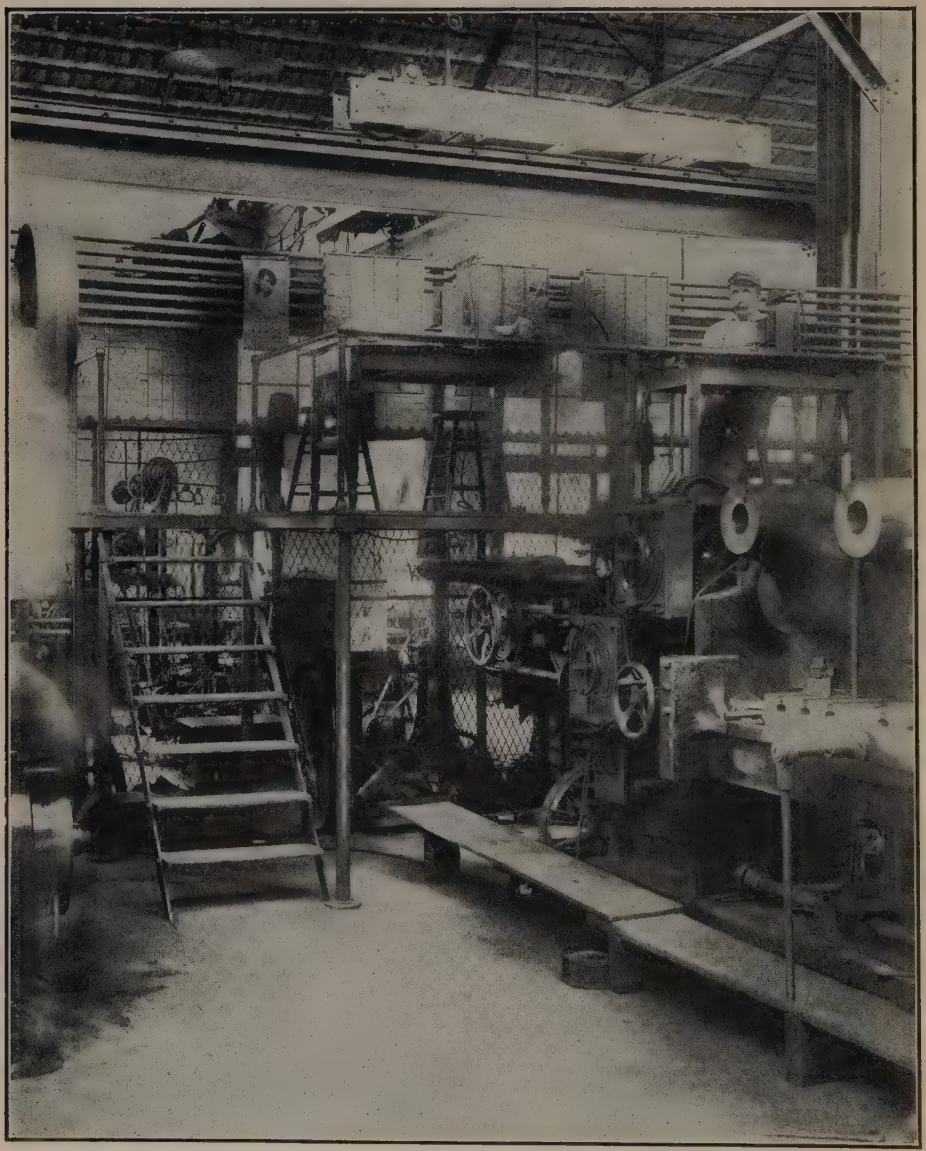


FIG. 14.—Raised platform for gang bosses. This platform overlooks the entire department.

do any clerical work at his desk, he is always in position to oversee his entire force. He can also be readily reached or signaled to by his men. The move material boss is also located on this platform, where he can have quick access to the shop route rack. A large department of seventy to one hundred men is too often run by one man. Even under scientific management, which takes so much off the shoulders of the shop bosses, it would be impossible for one man to give proper attention to this number of men. A few men, distributed over a comparatively small area, can be instructed and helped by a gang boss, whereas it sometimes happens under the common form of management that with a large gang, the boss has not seen or had speech with some of them all day. This is not an exaggeration, but is a condition that I have actually observed. Much greater efficiency can be obtained from the individual when working alone or in small gangs. This subject will be treated in a later chapter and the reason for it explained. If a gang is too large, each man has to lose considerable time each day waiting on the gang boss for instruction as to his next job or whatever he may need. This wait is expensive, especially if the man runs a machine which eats its head off at the rate of $2.00 per hour when idle.

4-F. Functions of the Speed Boss

The functions of the speed boss are a new departure incident to scientific management. This man is one of the shop representatives of the planning department, and is directly responsible to the shop engineer. All time-study work is in his charge and he has control of the tools, speeds, feeds and cuts on all machines. The gang bosses are responsible for the men and the work, including the setting of the latter until they are under way, but the control of the items above mentioned is up to the speed boss. A complete description of time-study work, how it is carried on, its analysis, and the creation of the instruc-

tion cards from these studies, will be treated in Chapter VII; also the methods of determining and paying bonus.

Much depends on the accuracy of a time study, both as to the methods used and sequence of the operations and tools, as well as on the judgment of the man. He must know how to analyze and plan work so as to get the best results and must see that the standard manual operations are properly speeded. He must take careful note of possible improvements and report them to the shop engineer. Correct and fair bonus prices depend on accurate time study as a basis, and the strength of the whole scheme of management centers finally in this feature. The use of the stop watch is at first liable to arouse opposition until the men realize that they are to benefit from the data obtained, and it is up to the time-study man to see that the men are not antagonized. If he is careful and fair, there will be no serious opposition. It is a radical departure to stand over a man, watch in hand, sometimes for several consecutive days, noting his every move and the time thereof. The man should not be blamed for objecting to a thing so unusual which he does not understand, so it is of first importance to see that the object of it is fairly and clearly explained to him. He has absolutely nothing to lose and much to gain by these methods, as he will soon see for himself. Many men, especially apprentices, are able to derive much benefit from the instructions given them while under the stop-watch observations. I have known many men who, at first opposed this method, later declared they did not know that there was so much to be learned about their trade, or who did not realize how much they could really accomplish until put to the test.

CHAPTER V

5-A. The Creation of a Stores Department, the Methods of Classifying and Housing All Material (Rough or Finished) Not in Process of Manufacture, and the Ordering of Stores Either to be Purchased Elsewhere or to be Made in the Shops

5-B. The Perpetual Inventory or Stores Ledger, Showing How It is Kept Up to Date and Checked to always Agree with the Actual Stock

5-C. The Means Used to Get Correct Returns for all Times Expended on Work, whether as Expense or as Productive Labor, Including Operation Times.

5-D. The Combined Cost and Route Sheet, and the Methods Employed to Distribute and Collate all Material and Labor Charges as well as Overhead Expense.

The subject of stores is an important one. The writer has seen many plants where no sufficient check was kept on either rough or finished material on hand. Stock of all kinds was allowed to lie wherever it had been dropped when first received, or left by the workman who happened to have used it last. A company does not keep its cash lying around for anyone to pick up and use who may feel so inclined. A workman is not allowed access to the office safe to take money on account. Why should thousands and even hundreds of thousands of dollars' worth of material be left lying about promiscuously, unrecorded and uncared for? This material represents money, and the chances are that the average company will have a value of ten or more times the amount of its cash balance in the bank tied up in material lying around in a confused condition. Large losses are occurring daily from the lack of a proper stores system to keep material from being lost, wasted, or allowed to lie unused.

Material is often requisitioned from the purchasing agent because it is easier for the one needing it to do this than to investigate and overhaul stock in the yard or elsewhere. One instance is recalled where a 10-ton lot of large rivets was discovered while operations were under way to inventory and centralize all stock. These rivets were in the original kegs which had never been opened, and were buried under hundreds of empty kegs and boxes in an old shed supposed to contain nothing but old packages. They had been overlooked and had lain for a year or two while new lots were being bought periodically. In another case a thousand pounds of copper was found lying back of an old shed, and still another example of the need of a stores record was the finding of certain machine parts worth thousands of dollars. These parts were more or less standard and were continually being used, but had accumulated in odd lots and at odd times and some of them particularly were found in odd places, while apparently no one knew they were in existence. After they were duly recorded and placed in stock, it took nearly three years to dispose of them. One company periodically inventoried a large lot of material which had once been in existence. Investigation brought to light the fact that about 30 per cent of the stock account had to be charged off to agree with the correct inventory, as part of the original lot of material had been gradually used or scrapped and the remainder was found to be obsolete and of little value. It is no uncommon thing to find stock parts that have been put out of sight by the workmen for future use, unknown to the officials. Parts are often hidden in this way, perhaps with the best of intentions on the part of those responsible, but at a loss to the company because some of them are never used, while others are made to take their places. Where no stores supervision exists there will always be found many costly examples of such conditions.

Think of the influence on the workman! If the company does not care enough to keep track of its own property,

why should he? He is not paid for that and does not feel he would be thanked for economizing. As a matter of fact, under the ordinary form of management, it would not be known that he was economizing. Neither would he be thanked for "butting in" if he saw another man wasting the company's material. If he spoils one piece, he knows where he can get another, and so it goes. The writer has known a man to be away from his machine one or two hours out of ten on the excuse that he was looking for certain material. Undoubtedly he was. The blame is not on him, however, but lies with the heads of the establishment. If some who read these lines will look around them, study the existing conditions in their own shops and then sit down and figure it out in dollars and cents, they will probably find food for thought. A dollar saved either in material or labor, or both, is a dollar profit—all profit—worth six to ten times a like amount of new business.

It is a common criticism that it is nothing more or less than red tape to require a written order (material card) when an employee wants a pencil or a screw, worth perhaps but a small fraction of a cent. On the face of it this appears to be true and it would seem to cost more, as some claim, to make out a material card for a pencil or a screw than either of them is worth. When one considers, however, that these are the extreme cases, picked out to exaggerate or perhaps to condemn a method, and remembers, too, that these seemingly foolish requirements affect only a small percentage of the total values the methods are to govern and control, the matter then assumes an entirely different aspect. Pencils, erasers, etc., should be periodically drawn in reasonably large quantities on a material card signed by the department head. He must anticipate his wants so that once a week perhaps he can make his order on stores for the few supplies he will need. This method teaches him to watch carefully the cost of running his department, does away with the continual annoyance

caused by having to frequently make out a material card for a small issue of stores, and at the same time make it easy and feasible to handle all kinds of material through the same routine as is required for more valuable stock.

In an average business, probably ninety-nine per cent of all the stock is such that it is necessary for economic operation to have it under absolute control. As above stated, it all represents money, not a cent of which should be wasted or left unaccounted for. Thus we cannot make exceptions for one or two of the smaller things, as these exceptions would cost more in a dozen ways than the cost of handling the small parts under the same routine required for the balance—say ninety-nine per cent—of the stock would be.

5-A. The Creation of a Stores Department

It should be clearly understood that the prime object of a proper stores system (including proper storing, control and perpetual inventory of the stock on hand and in process) is not solely to keep a strict account of debits and credits to the stores account, but

1. To know what stock is needed for the prompt and efficient management of a business.

2. To know where each and every item of stock is, so it can be promptly obtained with a minimum of cost for getting it out of stores and into use, and to keep absolute control of it while in process of manufacture.

3. To have stock on hand when it is wanted, and to provide a means to automatically replenish stock getting low before it is entirely exhausted.

4. To know the amount required for the prompt and economical running of jobs and the fulfillment of the orders.

5. To prevent tying up of material, labor, and its share of overhead expense in too large quantities.

6. To know that a correct balance is kept so that stores on hand at the end of one month, plus that purchased that

month for stock, minus that drawn out the same month, exactly equals the balance found to be on hand at the end of that month.

7. To know that all material used (with a minimum of waste) has been properly charged to an expense or job, and the stores account credited.

8. To give an exact record of the consumption of each item for any period, where each lot was obtained, when, in what quantities, the whole cost, or correct inventory valuation of it, and for what each piece was used.

9. To keep a perpetual stores ledger up to date showing the unit balance (either piece, pound, foot or other unit of measure) and a correct inventory value for the quantity on hand at that date.

10. To insure and maintain the accuracy of the stores ledger perpetual inventory, including the automatic checking of the same both by classes as well as for each item each time stock is ordered to replenish a depleted supply.

The kind of business, the geographical arrangement of the plant, size and location of the buildings, departments, etc., all have an important bearing on the arrangement and location of the various stores. Some stock can be stored in the yard uncovered without injury to it, but it should in every case be systematically piled or racked (in some cases clear of the ground), leaving plenty of aisles of sufficient width. Stock once located should have a lot number, which should appear on the pile or piece. The place once allotted to the particular kind of stock should never be allowed to have but that particular kind of stock upon it. Should this stock be replaced by another kind or done away with, then the location becomes available for a new item. This classifying and grouping particularly applies to pig iron, lumber, plates, structural steel, rough castings, etc. Each class of stock should of course be stored together as far as possible.

After the kind and approximate amount of stock that is to be housed indoors has been determined, the location

of the store rooms (one or more) must be decided. These should be so located as to give easy access to those persons or departments using or making the kind of stock each is to contain, so reducing to a minimum the handling expense. Stationery should be kept in a separate place, preferably in the office or planning department, in the special care of one man, under lock and key. The stock for the manufacturing department should be as near as possible to the shipping department, especially if the business is one which ships goods in any appreciable amount directly from stock.

Right here it would be well to call attention to the fact that an institution's inefficiency is very often due to the lack of a sufficient stock on hand. The argument will invariably be made that "we can't do that in our business," or "we never make a thing twice the same." In point of fact, the author knows from personal experience that the company without a proper stores system does not know whether a part is made twice the same or not. It has no conception of what the demand is for even standard commercial articles. The lack of this knowledge is far reaching. It is usually found that certain material is being bought periodically in small quantities at a much higher price than would be paid for it if there was an exact knowledge of what was required and a several months' supply intelligently purchased. Too much is taken for granted, or is based on the judgment of one or more men, who think they know many details of their work, but investigation, based on actual record, often proves their judgment faulty. Scientific methods applied to stores and to taking inventory often show most remarkable results. Where but twenty pieces of a kind are used in a year, it is obviously cheaper to make them in lots of eight or ten for stock at a reduction in cost and carry them through a period of two to six months than to rush even one through, perhaps having the work done expensively by an inferior man and usually breaking up the time of some other job.

In some cases the labor cost on parts can be reduced 80 per cent by the change in methods even when dealing with small quantities of eight or ten pieces. Even such small lots give satisfactory results when methods, tools, time studies and determination of bonus are carefully planned, showing an immense saving in cost to the firm, to say nothing of the delay which is avoided. The interest on the value of the stock tied up for two or four months is practically negligible when considering the other savings mentioned.

Requirements for castings should be anticipated and those in common use should be kept in stock ready to be delivered to the shops on an hour's notice. It is most important to have castings either on hand or quickly obtainable, as it usually requires more time to make the castings in the foundry than it does to machine them after they reach the machine shop.

I have never yet failed to find a foundry that was willing to make and carry a reasonable amount of stock of the kind that it was assured would eventually be taken off its hands. This plan has the advantage of giving the foundry a chance to make the pieces as opportunity offers. Some classes of foundry work admit of running small work in the same flask with larger pieces at practically no additional cost for labor. If this is not done the foundry labor cost of a piece made to order on short notice is often more than the price received for it. It is obvious that this arrangement can only be extensively carried out in connection with an exact knowledge of the demand, which knowledge can only be obtained through a proper stores system. This method is practically the same whether the shop runs its own foundry, or buys castings from the outside. In some cases the same method can and has been carried out in regard to other kinds of rough or semi-finished material, such as forgings, steel and bronze castings, and other forms of rough or semi-finished stock.

All material except that obtained specially for use on

some unusual job should be purchased or made for stock. By doing this, it becomes available as a stock article, for use on any work under way or contemplated. Passing it through stores also brings it into the properly indexed

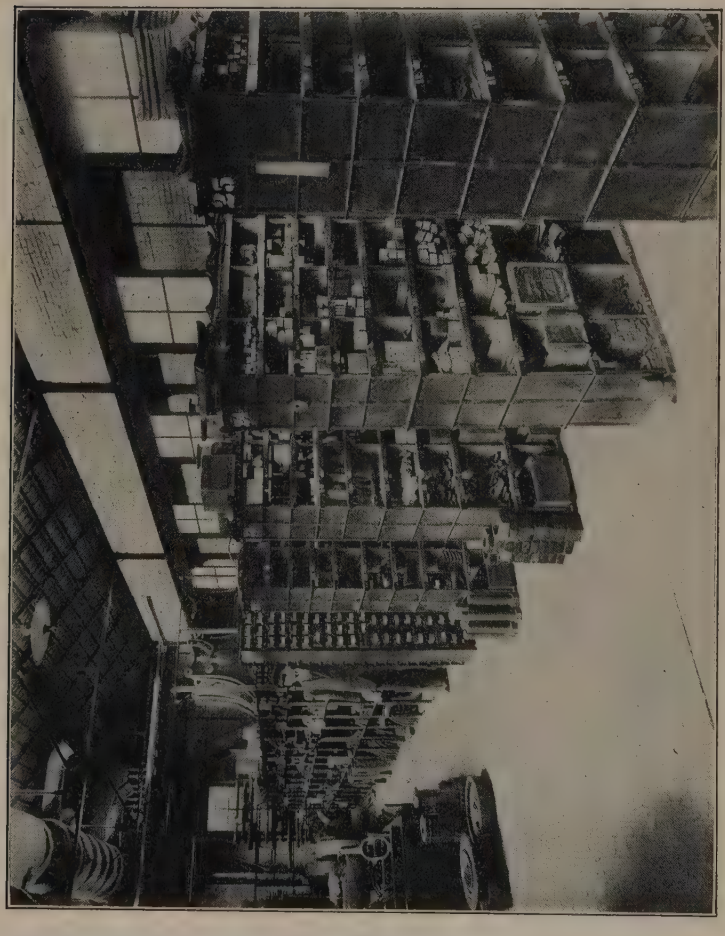


Fig. 15.—Part of the stores room of the Ferracute Machine Company.

and classified record (perpetual stores ledger) which forms a complete and easily found history of each piece. This method also has the further advantage, where a similar material is being continually ordered, of saving considerable clerical work in charging material up to one job which may be deferred in shipment with the result that certain

of the parts are used for some other job. Drawing material out of stores directly to the job just previous to the time it is to be used avoids much of this extra clerical work.

All racks or shelf units should have section numbers

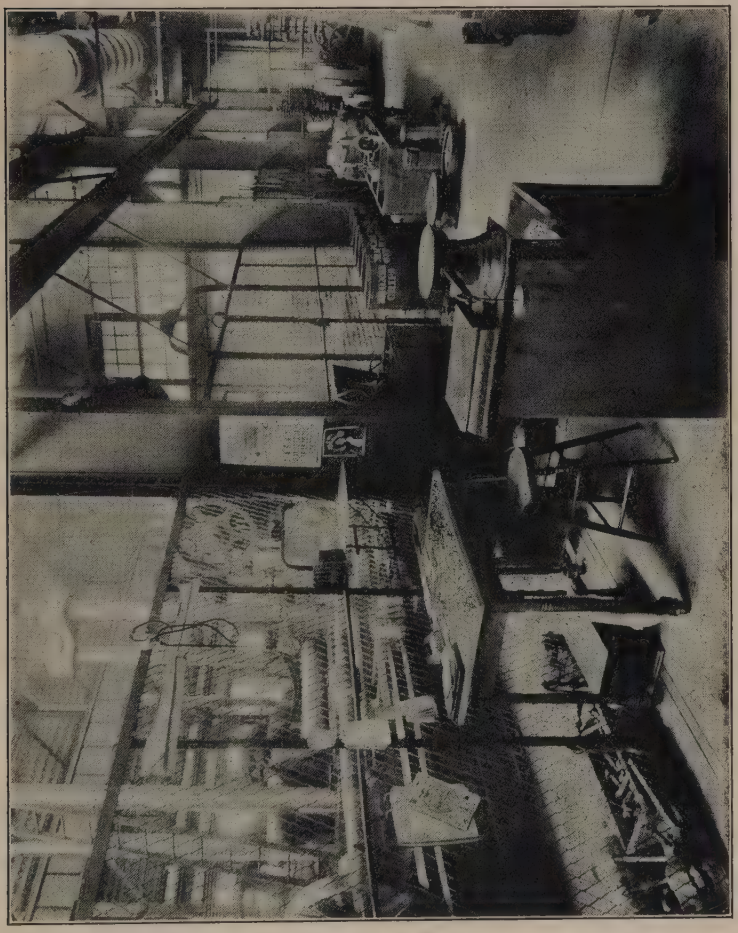


Fig. 16.—Another view of the stores room shown in Fig. 15.

and each shelf, bin, or compartment should have a space number. As explained later in the description of the stores ledger card, these numbers appear on the card and form a direct reference or guide to enable the particular item to be immediately located. The accompanying illustra-

tions, Figs. 15 and 16, show a section of one of the store rooms of the Ferracute Machine Company. In Fig. 15, showing the large racks, can be seen the section and space numbers. Bronze, brass, and other valuable scrap metal, including chips, turnings, etc., are charged into stores at the prevailing market price for this material. They are kept in iron receptacles provided for the purpose, properly stenciled with the names of the stock they are to contain (see Fig. 16). The gang bosses are responsible for seeing that each different material is promptly delivered into stores with a material card correctly filled out, credited to the job from which the scrap metal or chips come.

The stores keeper neither receives nor delivers any material, without a signed order, made out by a recognized authority. When issuing material, the stores keeper notes opposite each item supplied on the material card, the section and space number. This is done as a check to assist the stores clerk in the planning department when he credits stores with the material taken out. All material is moved to and from stores by the move material boss. This part of the routing of the piece will be described more fully later. The moving order designates the section and space to which each piece or lot is to go. The stores keeper is responsible for the card being correct as to wording or symbol of the piece actually issued, before it is forwarded by him to the planning department. The stores keeper has absolutely nothing to do with the stores ledger, this being in the direct charge of the stores clerk, as explained below.

5-B. The Stores Ledger, or Perpetual Inventory

The stores ledger should be on the vertical card filing principle, using a card preferably 5×8 ins. on end. Each article of stock should be recorded on a separate card. This applies to all stock, whether stationery, lumber, structural steel, coke, coal, pig iron, machine parts, or anything else. Take for example dimension lumber; 1-in.

STORES CARD — Form F. A. P. 7 — FERRACUTE MACHINE CO.

OBJECT: Rams, with clamps, studs and bushings. Drawing 10177–

Order in Lots: 25 — Danger Limit: 10 — Minimum: 5

Number or Size: R1P3a — Section: 6 — Space: 11 — Unit: piece — Remarks:

Date 1908	Quantity Ordered	Order No. Job No. or Purchase	Quantity Received	Quantity Delivered	Quantity Balance	Price	Amount	Cash Balance
~~7/12~~	~~10~~	~~L460~~						
9/17		L460	10		10	23.10	231 01	231 01
"		24133		2	8	"	46 20	184 81
9/24		L465		5	3	"	115 50	69 31
11/2		L466		✓	2	"	23 10	46 21
~~11/2~~	~~20~~	~~L919~~						
11/10		L919	20		22	12.54	250 84	297 05
12/1		L1101		10		13.50	135 00	162 05
12/5	20	L1191						

FIG. 17.—Stores Card. These form the stores ledger or perpetual inventory.

spruce boards of random lengths and widths would be on one card and the unit of measure would be the board foot; if, however, 1-in. boards were kept grouped according to the widths and lengths of the boards, each different size would have its own card. Pig iron, although the same brand, and of practically the same analysis, might be carried on several different cards, marked in addition to the brand and analysis by lot number, so as to keep the values of the different lots separate. Again, metal plates or sheets would be listed as different-sized plates, each different-sized plate having a card by itself. Three-inch boiler tubes would be listed on different cards according to the lengths. Three-inch by 12-foot boiler tubes would be on one card, 3-in.×9-ft. on another card, 2-in.× 16-ft. on another, etc. If a 2-in.×4-ft. boiler tube was required, and this size was not in stock, the nearest size being a 10-ft. tube, the 10-ft. tube would be drawn out of stock and the card credited. After the tube had been cut at 4 ft., the 4-ft. piece would be charged to the job on which it was to be used, and the 6-ft. length returned to stock; a new card would be made out and a new stock created for 2-in.×6-ft. boiler tubes. Machines and similar parts are handled in a similar manner. Each different kind of piece, or similar pieces in different stages of manufacture have their individual card. Each stores card should have the name and brief description of the piece clearly shown at the top, the symbol, location of the stock (section or space), unit of measure, as well as the minimum and maximum quantities and the danger limit. Reference to Fig. 17 shows the type of card preferred by the writer. As will be seen, this card shows the unit balance, value per unit, and the value of the amount of stock on hand at the time.

A stores ledger on the card principle as above described and consisting of eight or ten thousand cards can be handled by one man. The stores ledger of the Ferracute Machine Company (see Fig. 18) consists of between six and seven

thousand cards, and seven or eight hours' work by the stores clerk at the end of the month enables the total value of the stock to be determined. One particular object in having each and every kind or size of piece on a separate

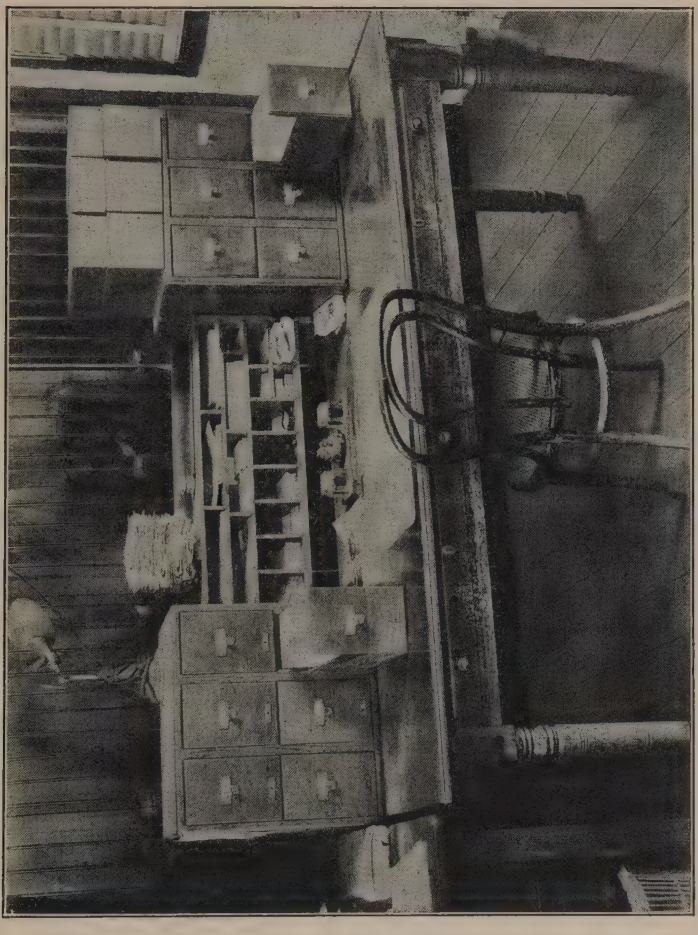


FIG. 18.—A convenient arrangement for a stores ledger. Capacity, as shown, about 10,000 cards.

card is that this method makes it possible to tell not only how much of each kind of stock there is on hand, but also what sizes, etc. Knowledge of the fact that we have ten thousand dollars' worth of 3-in. boiler tubes on hand or that we have so many feet of 3-in. boiler tubes on hand

is of no particular value unless we know the specified sizes of the tubes in question. This is particularly so in the case of plates. The idea is that the stores cards are the reliable record of what stock is in existence. If we want a 48×96-in. plate, we want to be able to tell this from the record, and to know exactly where it is stored. If one of these plates is cut and only part of it used, the part remaining goes back into stores and appears on another card showing its size after having been cut to the new dimensions.

It is extremely important and necessary that the stores ledger be kept up to date, as every order sent to the planning department must first be checked out of stores, to determine whether the material is in stock or in process of manufacture. This cannot be done if the stores clerk is behind in his work. A stores ledger also forms a very valuable record as a quick reference from which to get a cost of any article used by the firm, whether made by them or purchased outside. This is of prime importance in connection with the estimating department and the engineering room. Further than this, new work on order can be intelligently designed so as to use standard or other stock parts on hand. This also applies to odd parts on which the drafting room is kept informed, so that they may be looked up and disposed of at the earliest possible moment.

When a change of design is contemplated by the engineering or drafting rooms, they consult with the production clerk, who informs them as to how much stock is on hand of the particular kind under consideration. If the design is to be changed, the production clerk is careful about replenishing a depleted stock of articles which the change in design will affect. The science of stores keeping is one regarding which a majority of institutions are particularly ignorant, and few of them realize the immense loss occurring through lack of knowledge of what stock they have, of its value, or how economically it is being used. A further advantage resulting from a correct stores system is the value of knowing at all times exactly the amount

of stock on hand or in process, especially in case of loss by fire. A modern stores ledger kept up to date is often sufficient proof for an insurance adjuster to enable him to satisfactorily adjust a loss. This also is true of a proper cost-keeping system, to be described later. Both of these records may prove to be the deciding factor of some financing deal profitable or necessary to the company.

A common form of material card (or stores issue) is a 3×5-in. card like that shown in Fig. 19. This same card

MATERIAL CARD — FORM F. A. P.-66 — FERRACUTE MACHINE CO.

No. — DATE: 6/13 1911

DEBIT 27212a — Dr. Check J. — CREDIT Stores — Cr Check M.

Quantity	Description	Price	Amount
1	Shaft P2 rough to draw. 6497		6 42
1	Shaft collar finished to draw. 10390		63
1	Clutch slide bushing finished to draw. 8157		62

Ref. No. _____ O. K. by C. H. Clausen Foreman — Storekeeper R. E. Baker

FIG. 19.—Material Card. No stock received into, or delivered from stock without one of these cards signed by a duly authorized person.

is used for credits to stores and for debits to stores, when properly signed by a duly authorized person, and is the only medium recognized by the stores keeper on which he is authorized to issue or receive stock. These cards are turned over to the stores clerk daily and from them he makes his debits or credits to the individual stores cards. The material cards are priced by him and the amounts computed at the time the entry is made on the stores card, after which they are passed over to the cost clerk to be posted to the various cost sheets. Material purchased outside for stock

is charged into stores from the original invoices, after freight, cartage, etc., have been added or subtracted, as the case may be. Of course, all invoices are approved by the purchasing agent before reaching the planning department, he obviously being the only one capable of approving the correctness of the charges, as far as prices are concerned.

The different classifications desirable for a stores ledger depend on the kind of business. Generally speaking, the stores ledger is indexed alphabetically or by symbol and the cards for each different class of stores are kept together. All rough stock is in one section, all finished machine parts in another, miscellaneous or commercial articles in yet another, rough castings in another, etc. This method not only expedites the handling of the stores ledger, but assists in the quick finding of any particular card. It also enables the stores clerk to subdivide his monthly report so that the value of each particular class of goods is shown in the total. Parts made for stock are charged into stores from the material card, Fig. 19, which accompanies the move material order, conveying the stock from the last machine or bench to the stores room. The stores keeper signs the card and forwards it to the stores clerk, who is thus notified of the arrival of the material into stores and makes the necessary debit to the stores card for that particular article. The cost of this stock is obtained from the cost sheet to which the material and labor used in connection with the job was charged, plus, of course, its proper share of the overhead expense. These sheets are closed up and the cost figured under the direct charge of the production clerk.

The majority of orders on the stores department originate in the planning department. When work is planned, routed, and scheduled, the material or stores issue card (Fig. 19) is made out at the same time. The minimum quantity necessary to fill the order has been accurately determined. The material boss presents this card to the

stores keeper when he goes after the material in question. This method insures the proper wording on the stores issue card as well as the correct debit and credit notations. If a lot of parts are wanted out of stores, say for an entire machine, a list is attached to the card and remains with it. After it is priced and posted to the cost sheets, the card (and list, if there is one) is filed under the job number to which it applies. This method puts nearly all the clerical work on clerks in the planning department, rather than on the men or bosses in the shops.

The above-described methods represent far more than a smooth running system of stores accounts. The basis is an exact knowledge of requirement, and an absolute control of both stores and stores accounts from one central department. The control of the amount of stores to be issued for each job, combined with an actual check on each item while in process of manufacture, as well as when in the stores rooms, eliminates all preventable waste. Combined with the other features of the form of management being described, stores handling along these lines becomes one of the great waste-reducing factors. It is not unusual to find a company determining the amount of material in a finished product by measuring or weighing the article or its parts after it is completed ready for shipment. The writer has known the amount of material charged to a boiler to be obtained by measuring the plates and counting the tubes and rivets in the finished articles. The dirt floor of this same boiler shop yielded tons of good rivets under the screening process.

5-C. The Registering of Time Consumption

The charging of time and the distribution of wages to the various expense items and jobs is an important subject, and when neglected often involves a loss of thousands of dollars yearly. The only accurate way of determining the work hours of each man is by a time clock, which

stamps in ink on his time card the time he starts and quits work. Under scientific management the time is not stamped in hours and minutes, but in hours and hundredths. This method has a number of advantages, the greatest being its accuracy, as the time is paid to the nearest tenth of an hour. As a tenth of an hour equals six minutes, it is obvious that the maximum error can never be more than three minutes, whereas under the common method of using quarter hours, the maximum error can be eight minutes. The new method gives a possible error of but $37\frac{1}{2}$ per cent of the common method. It is fairer to the man. If he is one or two minutes late, it allows him to commence work at the nearest succeeding tenth of an hour instead of requiring him to wait fifteen or perhaps thirty minutes, as in some shops.

Another advantage of the decimal system is a simple computation of wages by the multiplying of any rate by the number of hours and decimals, cutting out the common fractions and allowing greater accuracy, especially as all wages are computed to mills.

Each foreman and gang boss is given daily a job time card (Fig. 20) for each man in his charge, on which is noted the man's name and number and the date. This time card is ruled into five coupons, on one of which is noted briefly the work number of the job on which the man is working, his number, the time he started and finished, what the operation was, and the time consumed on the operation. When given the next job, and before work is started, the time is noted and the coupon filled in. It is apparent that the only correct way of getting time returns is to have the time stamped on the card or coupon instantly when a change is made from one job to another,—neither before nor after. If the gang boss or foreman is competent to handle a gang of men, he can be trusted with the time cards for those men. In large shops or departments a shop time clerk should be employed. The starting and stopping time for each operation should be stamped on

TIME CARD

Man No.

Name

Date

FORM F. A. P.-17c FERRACUTE MCH. CO.

TIME CHECK

The following entries are correct.

Signed

FOREMAN.

Hours Allowed

Rate

Amount

Man	Machine	Hand Time / Mch. Time		Commenced / Finished	Total Hours
Work Number	Operation				Rate Wages
	Date		Dept.		Am't.
Man	Machine	Hand Time / Mch. Time		Commenced / Finished	Total Hours
Work Number	Operation				Rate Wages
	Date		Dept.		Am't.
Man	Machine	Hand Time / Mch. Time		Commenced / Finished	Total Hours
Work Number	Operation				Rate Wages
	Date		Dept.		Am't.
Man	Machine	Hand Time / Mch. Time		Commenced / Finished	Total Hours
Work Number	Operation				Rate Wages
	Date		Dept.		Am't.
Man	Machine	Hand Time / Mch. Time		Commenced / Finished	Total Hours
Work Number	Operation				Rate Wages
	Date		Dept.		Am't.

FIG. 20.—Job time card.

the card by means of a time clock, although this is a detail. The cards are sent to the time keeper at the end of each day. They are totaled up and then taken out the next morning to the time clock on which the man registers "in" and "out" and checked so as to be sure the total hours distributed over the man's previous day exactly agrees with the total hours he worked, as shown by the time clock, from which time clock record he is paid.

When these cards have been totaled and the work numbers transposed to the job numbers on which the different work is being made, the time keeper computes the value of the charges for each job on the job time card. These cards are then added up on the adding machine and the total posted in the daily wage distribution book by the time keeper. The cards then have the different coupons sliced off to be later sorted according to the various jobs. After the wages have been distributed to salaries, business, shop-keeping, factory, plant and merchandise jobs, the total hours and wages distributed to each of these items are added up and posted in the daily wage distribution book, and checked to agree with the original total entered by the time keeper. The time posted from these cards to the cost sheet is again added and checked with the daily wage distribution book so as to guard absolutely against any error and to insure that every dollar paid out in salaries and wages has been properly distributed on the cost sheets, Plates VII and VIII. These job time card coupons are sorted out by jobs and posted to the proper cost sheets. As each labor column on the cost sheets is headed by a work number, the coupon must be posted to the column having the work number which corresponds with the work number on the job time card coupon. After the coupons are posted they are filed away by jobs with the material cards. The job time card coupons and material issue cards may be destroyed at the discretion of the production clerk after a job has been shipped and the cost sheets closed and checked.

The accuracy of the above method of accounting for time is apparent when compared to the ordinary methods where the time keeper makes the rounds of the shop once a day, taking down from each man the time which he says he has spent on each job on which he worked the previous day. It is absolutely impossible for the average workman to compute the time given to each job, and it is not reasonable to expect him to consume considerable time each day in making out his own time card or in keeping memoranda to be used next day in consultation with the time keeper. Further than this, the old method does not admit of much accuracy, especially where a man works on a number of jobs in a day. Under the old methods the results are bad enough where a time keeper actually gets around each morning to collect the time of the previous day, but often this will be put off until night and the men easily confuse the time of that day with that of the previous day. If something arises to interfere with the time keeper getting around each day, he simply puts it off. It is no uncommon thing to have a time keeper try to catch up on his work by getting the approximate times of the individual men on jobs performed several days before. The writer does not hesitate to say that at a conservative estimate the old method is responsible for the wasting of at least from one-half to three-quarters of an hour per man per day, to say nothing of the absolute worthlessness of such returns.

All clocks in the shop are equipped with a decimal dial for the use of the various gang bosses and foremen, and time is not spoken of in hours, and minutes, but in hours and tenths. All time stamps are in decimals. This is a radical departure in the item of time keeping incident to scientific management.

The methods above described result in great accuracy and absolutely eliminate the large common errors of favoring certain jobs while others are loaded up with charges for labor which does not belong to them. A small job per-

haps taking a great deal of time is often so favored and the time charged to a large job on which it is not likely to be noticed.

5-D. The Combined Cost and Route Sheet

This sheet was devised by the writer after wide experience with many more or less common designs of cost sheets or cards, and to the best of his knowledge is the only sheet being used as a combined cost and route sheet. Two reproductions are given here, the first one, Plate VII, showing the cost sheet for a lot of pieces in process of manufacture, partly finished. The second reproduction, Plate VIII, shows the job completed and the cost summary; using altered figures to represent the overhead expense or burden. Before taking up in detail the means employed to collect the information shown on these sheets, a summary of the information there recorded may be of interest. This consists of:

1. A brief specification of the job or piece, including the drawing or sketch number, piece symbol, etc.
2. The date started and date wanted, and date finished.
3. Stores clerk's check showing that the necessary records have been made on the stores card.
4. The routing of the piece, giving the sequence of the operations and the machine or bench where each is to be performed, the operation symbols, the department symbol and work number for each separate operation.
5. A record for the guidance of the cost clerk to tell him whether material is to be charged from a material card out of stores or is to be furnished by requisition upon the purchasing department for which purchase a bill is to be expected.
6. Time elapsed from the issuance of the sheet until the arrival of the material.
7. Time elapsed after the arrival of the material before the first machine operation was started.

8. Time taken to perform each operation, as well as the total hours expended thereon.

9. Time elapsed between two successive operations.

10. A graphical record showing the location of the material at all times during its progress through the shops as indicated (see Plate VII) by the black line extending across the top of the sheet over the work number.

11. Showing the location of the material on any particular date, as per black line above referred to.

12. Whether the routing specified was adhered to, and if not, what operations were performed out of order. Note the graphical curve created by the method of posting time. This curve is broken if there has been any departure from the specified routing, and the break can be seen at a glance.

13. The amount of bonus paid, if any, on each operation, and the total cost of each operation.

14. Cost of the material.

15. Total cost of labor.

16. Machine time as separated from hand labor.

17. Departmental time.

18. An absolute check for the cost clerk to guard against posting time on the wrong job or in the wrong labor column.

19. Up-to-the-minute analysis of the cost by operations, giving at a glance, without any computation or cross reference, the cost of any specific operation, as well as the cost for material, sundries and labor to date on work but partially finished.

The cost sheets for stock jobs are issued by the production clerk and then are passed by him to the route clerk, who fills in the required routing, specifying operation, machine, department, symbol and work numbers. Work orders are then made out either by the route clerk or his boy assistant, after which the cost sheets are passed over to the cost clerk and placed on his file. The production clerk notes on the cost sheet the source of the material

above referred to. When a purchase order is issued the purchase order number (also casting purchase order numbers) is noted on the margin of the cost sheet. This forms a check for the stores clerk when charging material from invoices, so as to guard against posting to the wrong cost sheet. Each job has allotted to it the required number of work numbers. These are filled in across the top of the sheet in their numerical order.

This same form of cost sheet is used for all cost records, and if a complete machine is being built on one job, each separate piece of this machine (not in stock or coming through on a stock job for stock) is routed the same as above described for a single piece. In no case is the routing of one piece carried from one sheet to another. Work is so planned that one, two or three pieces, or more, may be routed complete on each sheet. For a large job it is evident that a number of sheets will be necessary, but the result is a complete file when the job is done from which can be obtained directly the actual cost of any one piece or any one operation, as well as the total cost complete. The value of this cannot be overestimated, particularly in connection with the cost for repair parts, etc. In connection with the time study and planning of operation times to be described later, it is essential that the cost records be such that data can be had from them at all times as to the exact progress of the jobs in the shops, as well as the time expended on them to date. The heavy black line extending across the top of the sheet immediately over the work number (in Plates VII and VIII) indicates the progress of the work through the shop, and the space to the immediate right of this heavy line indicates the location of the material at the time. If the last operation is finished the material is known to have been moved to its final destination as indicated at the top of the sheet. As fast as an operation is completed in the shop, the coupon on the time card is stamped " Done " by the gang boss, so that when time is posted therefrom the next day on the

cost sheet, the heavy line is extended across the column headed by the work number appearing on this time card coupon.

The inks used are of various colors. All regular entries for material and labor are made in black. All credits are made in red and all overtime (which is reported always by means of a red job time card) is entered in green. The monthly totals for inventory purposes are always in yellow. The color scheme has proved a great help, as it shows at a glance any alterations or corrections, and if overtime has been expended on the job, how much.

The order-of-work clerk and superintendent by consulting these schedule cost sheets can determine the progress of each piece through the shop and the status of the work on any particular machine or job at any and all times. This work is all done in the planning department and the record is accurate. It is not necessary to go around the shop looking for a piece before its location and condition can be determined. Reference to the schedule cost sheet, as above stated, shows the location of the piece; reference to the route rack, in the production department, shows at a glance what work, if any, is immediately ahead of that particular piece. As explained elsewhere, the readjustment of the position of these next-work orders in the rack insures the piece receiving the attention required. By these methods many jobs can be followed by one man and followed intelligently where only a few could be handled without these adequate records, and then only more or less superficially.

The possibilities of this design of cost sheet are many. The principles used may be modified somewhat to suit conditions. In other cases the scheme presented can be amplified, with the result that sheets can be devised along these lines that will give any desired amount of detail for any kind of business or work. For financiers this type of sheet can be developed into a most valuable adjunct to the present records; in fact, it would replace perhaps

many of those now in use for itemized museums of costs. The sheet described also lends itself to a very simple and complete analysis of expense accounts. Still another use is where man or machine records are wanted. As a combined cost and route sheet, however, it represents a new development.

CHAPTER VI

6-A. The Standardization of Methods and Tools
6-B. The Development of a Manufacturing System
6-C. The Handling of Erection Work

6-A. The Standardization of Methods and Tools

Standardization is a term which is used in a comparative sense except when applied to specific facts. A good and efficient standard for a detail or process of one line of business at one period of its development may be anything but an efficient standard at another. This is particularly noticeable when the standards apply to permanent plant and equipment. These last-named factors often represent a large percentage of the investment and must be utilized to the best possible advantage. Since standard methods may be correctly determined for any given condition, when the condition changes by the replacement of part or all of the equipment, new standards can be developed and maintained. The term "condition" as used here refers to a result developed by the methods under description and not to "condition" commonly found where no system exists.

There is no economy in replacing fairly good equipment with new of the latest type until conditions affecting its efficient use have been standardized, so as to insure the permanent efficiency of new equipment. The necessarily increased overhead charge resulting from the addition of new and expensive machinery might increase rather than decrease the cost of production where standardized conditions did not exist. Old equipment is often used as a makeshift to carry the blame for poor work and high cost, when lack of organization and standards is responsible

for the inefficiency. When a present condition shows each machine in repair, with proper cutting tools and necessary materials at hand, with sufficient work ahead to run at a maximum, and with each operator and foreman interested by a direct incentive to produce at his best efficiency, a fairly standardized condition exists. If, with the above variables under control, a standard cost is not realized, then the advisability of modern equipment becomes imperative.

Standards in practice should extend through the entire organization. This should be recognized in the engineering room as well as in the minor departments of the shop. If standards are not adhered to in the designs and detail drawings, the standardization of shop operations becomes most difficult. Previous chapters have repeatedly referred to the importance of keeping control of these items. Unless due thought and consideration are given in the engineering and drawing rooms, while the preliminaries are being worked out and drawings made, shop standards must be departed from.

In nearly every line of business making one (or only a few types of) product, though perhaps of many sizes, there are sure to be a greater or less number of pieces of similar design. Lack of proper standards, however, makes them enough different to cause their manufacture to be more difficult and expensive than it should be. The result is continual pattern expense, either for pattern alterations or for new patterns. The planning department cannot order castings ahead from the foundry, fearing change of design. Anticipation of requirements is impossible, either for rough or finished stock. The shop management cannot provide the right tools to economically machine such work, as the next similar piece may be just enough different to require different sizing. Perhaps the new part must even be machined in an entirely different way, and at much greater cost, just because one dimension debars it from being worked in the only really adaptable

machine in the shop. Lack of proper tool records in the drawing room is often responsible for this latter condition, and many thousands of dollars may be annually wasted in consequence.

Every engineering and drawing room should have a book of standards (a card index is better and more elastic unless the book is of the loose-leaf type), in which is recorded an up-to-date list of all machine tools, special small tools, cutters, millers, reamers, rose bits, drills, taps, jigs, templets, etc., boring bars, parallels, vee blocks, machine attachments and, in fact, all appliances used in the making of the firm's product. The capacity and scope of all machines should be given. Without these data designing cannot be economically and practically carried on. Jobs which would ordinarily be finished at a good profit have often been built in some shops at a loss, just because they were not designed so they could be expeditiously machined with the existing equipment. Careful planning in the drawing room is one of the essentials. We often see drawings used for handwheels, collars, screws, bolts, studs, and many other small parts of odd dimensions, when standard patterns, castings or forgings could have been used as satisfactorily. It is often interesting to examine and compare similar types of different makes of machines and note the varied assortment of minor parts that can often be found in some of them. Bolts and nuts particularly can be found in almost every variety of size and style; this requires the maker to supply (or the customer to purchase) perhaps six or eight wrenches, when a little care in the designing would result in fewer sizes and only one or two wrenches. The author recalls one machine with several babbitted shaft boxes which had an assortment of caps from five different patterns. A little redesigning made them all alike, and resulted in the adoption of a cap used on two other machines. Taper pins are another article found in all sizes and shapes, when a standard of two or three commercial sizes would ordinarily suffice. The commercial article is not only usually cheaper

in itself, but standard reamers at a low price are on the market also; if "specials" are used to suit individual whims, the article and tool costs are, of course, much higher.

Standards and series in designing are often overlooked where more than one size of a given type of machine is concerned. If the various sizes are worked out in a correct series, the work of detailing and symbolizing and all preliminaries to manufacturing are greatly expedited. In such cases the extremes of dimensions between the smallest and largest size are often within such limits that the standard method of routing incident to their manufacture can apply to all sizes. Time study and rate setting are also greatly speeded under these conditions, as often two time studies of, say, the second and fourth size pieces, will enable a correct rate to be fixed for each of six sizes, at a minimum of delay and expense. The designing at the Ferracute Machine Company has been carried on for years along these lines and has repeatedly proved of immense value to the author when fixing rates. A correct series also assists toward a more correct check on material and labor costs as well as total costs, other conditions being equal.

Coming now to the planning department, we find that standard practice is one of its chief essentials. The routine work here, as well as in all other departments, is standardized and each employee has a one best way of doing his work. This has been planned out for him and is incorporated into his instructions. Right here attention should be called to certain details in way of illustration. The printed forms in continual use in this department are about twenty in number, including those circulating between the production department and the shop and not counting duplicate or triplicate copies of drawings or sketches. These forms are carefully designed, and sufficient printed matter is ordinarily found on each one to make their use understood. In practice, however, they would not be sufficiently clear in themselves to insure their continual

use to the best advantage without complete, concisely-written instructions in the details necessary for successful manipulation. This would be too much to expect, especially when a clerk is replaced by a new man. The standard method to be followed is therefore recorded in the form of written instructions both for the assistance of each employee and to insure the perpetuation of their use. These cover all details in connection with each position, as referred to in a previous chapter. Standard records of all descriptions are essential. Without them the ideal is as far away as ever. They must cover eventually all branches of the business in detail. They should be centrally located and in charge of competent help. No set of records is of value unless always up-to-date and in concise form. Records must be dependable and easy of access; they are intended for intelligent use and are not for ornamental purposes. They are too often neglected and ignored, when, in fact, they are a most valuable tool if intelligently used and followed up.

Standard practice for shop operations is worked up under the direct supervision of the shop engineer. These instructions are based on time studies, the details of which are standardized and filled out on an instruction card for each operation. Time studies and instruction cards will be fully described in the next chapter, under 7-A and 7-B. As each detail drawing is received by the route clerk, it is analyzed by him or the shop engineer, or both, and the standard routing determined on. This routing, as soon as it is definitely determined by them, is recorded on the negative or original drawing, the drawing label being specially designed for this purpose, as explained in the second chapter (see Fig. 4). This method insures the maintenance of the correct routing for the future. Incidentally, it reduces subsequent routing to a simple clerical operation if the job is ever duplicated.

In the further illustration of this point, a few examples taken from actual practice may be of value. A bronze

ring (called a ring roll) was usually finished complete, except milling, on a Potter & Johnson chucking machine after which 104 corrugations or indentations were milled in the periphery on a plain milling machine. These corrugations were in two rows, staggered so the V-shaped grooves did not connect. Time study showed that a set of 80 rolls took a journeyman machinist 33 hours to mill. The use to which the rolls were put did not require the extreme accuracy obtained by this process (using index centers), so a special fixture was devised and built at a cost of less than $50, to be used in connection with an old, unused speed lathe. The writer demonstrated this fixture personally, corrugated a number of rings, and determined a standard time of 45 seconds per ring; this, too, resulted in an apprentice doing the work in the future instead of a journeyman. The result was that the milling machine, instead of being operated almost continuously on this job, was available for other much needed work, and the labor cost of the rings per set for corrugating was reduced from about $8.25 to 12 cents. This is, of course, an unusual example, and cannot often be duplicated. Another case involved the designing and construction of a special machine costing about $600 and saving the wages of fifteen men. Condenser glands being slotted at the rate of sixty per hour and manufactured in lots of 5,000 were tying up erection work. The operation was standardized, a fixture costing $27 was made, and two apprentice boys slotted them on standard time at the rate of 1100 per hour. These are not Ferracute Machine Company products.

The examples given above have involved the investment of some money for equipment, but many cases can be cited of great decrease in cost and immense increase in production, due solely to change of method and the standardization of operation times. A ram which formerly took 33.8 hours to finish complete, is now processed in 6.5 hours; the time on another and larger ram has been reduced

from 36 hours to 8.7 hours. One type of machine formerly averaging over 1400 hours, is now built in a little more than 300 hours. The accompanying table of labor comparisons involving almost all classes of machine and hand work at the Ferracute Machine Company, shows widely varying kings and sizes of work and what has been accomplished in the way of labor reductions and production increases, due to standardization of methods and times, with an almost negligible expenditure for tools or jigs, or other equipment.

The totals in the table show a production equal to 340 per cent. of the former output for the items considered, and the table is representative of the entire standard line.

A careful study should be made of this table, which includes over two hundred different operations and is typical of the gains possible by the establishment of standard methods and times. The object in listing so many items is to show the savings effected through a wide range of work with many different operations, and not to quote extreme cases only. Reference will be made to this table in a later chapter. In its preparation, care has been taken to be perfectly fair by using averages rather than extreme figures. The records show many items listed on which the hours consumed under day work and bonus are respectively more or less than the corresponding figures in the table. In the concluding chapter another table will be given showing the effects of this system and the methods being described on the finished parts as a whole, as well as for the entire plant's production.

When determining time allowances the personal factor must be provided for. No two men are exactly of the same skill, neither are they physically alike; consequently, prices must be made so that a reasonable variation in capacity between skilled and efficient men is provided for. This statement must not be interpreted to mean that an inefficient man can earn bonus money as well as a good man. It means that with the same job and equip-

TABLE I

Labor Comparisons

COMPARISON OF OPERATION TIMES UNDER OLD AND NEW METHODS

(All time expressed in hours and decimals)

Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time. Hours.	Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time. Hours.
1	AS	8.00	1.40	35	GR	.8	.07
2	DL	17.00	4.3	36	PL	14.8	4.15
3	TN	6.6	1.97	37	CV	1.75	.55
4	TN	4.00	1.75	38	PL	8.15	4.73
5	TN	2.5	1.10	39	BO, TN	5.9	2.50
6	TN	3.4	1.34	40	BO	6.4	.92
7	ML	3.6	1.54	41	BO, TN	7.00	2.82
8	TN	6.75	1.28	42	ML	3.00	1.4
9	TN	3.7	.94	43	DL, TP	5.65	1.14
10	BO	1.85	.4	44	ML	4.00	.5
11	ML	1.2	.61	45	PL	5.4	1.15
12	CV	1.95	.48	47	DL	6.00	1.6
13	BO	1.2	.46	48	DL	5.00	2.1
14	AS	50.00	26.60	49	DL	7.00	2.75
15	PL	18.35	12.00	50	DL	7.75	3.3
16	FH	1423.00	354.00	51	DL	10.35	4.1
17	PL	9.5	5.20	52	DL	17.5	5.4
18	ML	1.4	.56	53	DL	5.00	1.5
19	BO	.95	.16	54	DL	9.00	2.3
20	TN	3.8	.79	55	DL	7.8	2.7
21	TN	.6	.21	56	DL	10.00	3.3
22	GR	1.25	.44	57	DL	17.50	10.52
23	ML	1.2	.35	58	BO, DL	17.45	6.68
24	DL	.45	.055	59	BO, DL	3.10	1.15
25	DL	.6	.1	60	TN	2.00	.69
26	ML	5.25	1.19	61	TN	2.1	.7
27	ML	1.00	.50	62	TN	1.55	.64
28	FT	1.4	.41	63	TN	1.95	.65
29	BO	5.6	1.15	64	TN	2.5	.9
30	ML	2.75	.31	65	TN	2.9	.56
31	DL	11.6	5.98	66	TN	3.00	1.05
32	DL	1.2	.34	67	TN	2.35	.75
33	BO	18.00	2.62	68	TN	3.2	1.00
34	BO	9.00	1.52	69	TN	3.6	1.00

TABLE I—*Continued*

Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time. Hours.	Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time. Hours.
70	TN	3.00	1.10	113	BO	11.2	2.26
72	PL	11.00	4.4	114	BO	20.00	4.9
73	PL	18.2	8.41	115	BO	17.50	5.9
74	PL	16.6	11.3	116	BO, TN	2.2	1.3
75	BO, TN	5.82	1.89	117	BO, TN	2.00	.61
76	BO, TN	4.65	2.33	118	BO, TN	1.6	.61
77	BO, TN	7.75	5.85	119	BO, TN	2.00	.55
78	BO, TN	10.00	6.20	120	BO, TN	2.6	.5
79	DL, TP	3.5	.98	121	BO, TN	4.	.8
80	DL, TP	5.1	.85	122	BO, TN	6.3	2.74
81	DL, TP	5.6	1.00	123	DL	.4	.21
82	DL, TP	10.00	1.1	124	DL	.7	.08
83	DL, TP	8.75	2.8	125	DL	.5	.065
84	GR	.55	.065	126	DL	.85	.11
85	GR	.3	.06	127	DL	.8	.13
86	GR	.3	.056	128	DL	1.15	.37
87	GR	.8	.076	129	DL	1.3	.57
88	GR	.9	.08	137	ML	7	.5
89	GR	.53	.09	138	ML	.5	.09
90	DL	.06	.012	139	ML	.5	.10
91	TN	3.70	1.48	140	ML	.3	.11
92	BO, TN	4.4	.94	141	ML	.5	.11
93	BO, TN	5.05	1.3	142	ML	1.00	.21
94	BO, TN	4.00	1.2	143	ML	1.5	.25
95	BO, TN	6.2	2.00	144	CL, FI, PO	2.3	1.08
96	BO, TN	6.35	2.00	145	CL, FI, PO	2.6	.23
97	BO, TN	7.75	3.60	146	CL, FI, PO	1.7	.32
98	BO, DL	2.00	.33	147	CL, FI, PO	2.6	.31
99	BO	3.5	.9	148	CL, FI, PO	4.5	.39
100	BO	10.00	2.8	149	CL, FI, PO	3.00	.66
102	TN	2.30	.7	150	CL, FI, PO	4.2	1.10
103	TN	2.05	1.33	151	HD	.25	.22
104	TN	4.60	1.1	152	HD	.25	.17
105	GR	.92	.08	153	HD	.25	.10
106	GR	1.00	.10	154	HD	.25	.11
107	GR	1.25	.076	155	HD	.5	.17
108	GR	.8	.15	156	HD	.45	.26
109	GR	1.8	.16	157	HD	.5	.32
110	GR	.62	.37	158	PO	.45	.28

TABLE I—*Continued*

Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time Hours.	Chart No.	Operation Symbol.	Average Time with Day Work. Hours.	Representative Bonus Time. Hours.
159	PO	.25	.03	204	FO	3.46	1.67
160	PO	.6	.05	208	TN	5.00	1.9
161	PO	.6	.25	209	TN	7.55	3.4
162	PO	.8	.05	210	TN	4.00	1.20
163	PO	.9	.11	211	AS	578.00	150.00
164	PO	.8	.12	212	AS	20.00	5.75
165	PA	.2	.1	215	PL	7.66	3.09
166	PA	.28	.04	216	PL	12.30	4.28
167	PA	.44	.05	217	PL	9.35	4.25
168	PA	.3	.06	218	PL	16.75	7.4
169	PA	.25	.04	221	BO	4.9	1.59
170	PA	.5	.09	222	BO	4.3	1.65
171	PA	.25	.09	223	BO	5.45	1.6
172	GR	2.15	.42	224	BO	8.10	3.13
173	BO, TN	7.1	1.685	237	TN	2.5	1.57
174	BO, TN	4.5	1.8	238	TN	3.2	1.91
175	BO, TN	6.6	2.325	241	GR	2.40	.80
176	BO, TN	9.00	2.9	242	GR	3.00	.90
177	TN	7.65	3	243	GR	3.25	2.35
178	AS	57.40	23.3	244	GR	5.4	3.85
179	AS	75.00	27.7	245	GR	7.25	4.20
180	AS	98.00	24.43	246	TN, TH	10.50	3.40
181	AS	134.00	28.1	247	PL	21.70	8.00
185	AS	108.00	25.00	248	PL	20.30	8.40
187	AS	160.00	37.1	249	TH	11.55	2.80.
189	AS	50.00	14.4	250	ML	.35	.18
190	AS	55.00	21.95	251	DL, TP	.25	.14
191	AS	62.00	23.00	252	AS	308.00	141.00
192	AS	84.00	25.20	253	GR	4.00	1.57
193	AS	125.00	29.5	254	GR	2.40	1.33
194	AS	285.00	47.00	255	GR	3.90	1.55
195	AS	113.00	19.5	256	GR	4.00	1.74
196	AS	80.00	29.00	257	GR	5.50	2.62
197	AS	115.00	34.8	258	GR	6.90	4.90
198	AS	116.00	35.00	259	AS	185.00	115.00
199	AS	153.00	45.00				
200	AS	305.00	63.00	T	otal.....	5647.75	1671.865
201	TN	5.3	1.62				

ment a 2-hour job for one man may be a 2.2-hour job for another man, who is equally skilful, but who is not quite so strong physically or who may not have had as much experience on that particular class of work. Furthermore, it is to be understood that the best *normal* speed that can be maintained as an average is arrived at, and not *spurt* times. To meet these conditions, time allowances and bonus to be paid are worked out in a sliding scale. Following is a copy of bonus chart 208. This chart shows the increase in bonus *per piece*, as the average time for the lot (including preparation, etc.) is reduced.

CHART 208, FEB. 6, 1911

P 4 SHAFTS—

CE, FA, TN, and TH complete ready to GR from rough turned forging of 0.50 carbon steel, 6*L*. Drawing 12609-D.

Time Each.	Bonus Each.	Time Each.	Bonus Each.
3.35 hours	$.076	2.65 hours	$.146
3.25 "	.086	2.55 "	.156
3.15 "	.096	2.45 "	.166
3.05 "	.106	2.35 "	.176
2.95 "	.116	2.25 "	.186
2.85 "	.126	2.15 "	.196
2.75 "	.136	2.05 "	.206

Although the figures change every tenth of an hour on the chart, the bonus is figured exactly to hundredths of an hour. These charts are issued to the men in the form of blue-prints, one for each bonus job. They are kept on file in the tool room, to be called for in the same way as are blue-prints of drawings.

Incident to the determination and planning of the standard method is the use of the tools, jigs, etc., needed in the efficient carrying out of the routing and methods previously determined on. To this end the tool room must necessarily be developed to a high state of efficiency. A well-equipped, well-organized and efficiently operated tool room is to a shop what the heart is to the human body. When it fails to respond to the demands put upon it, a reduction and inferior quality of output results. In the

case of the shop, this means not only expensive delays, high cost and poor work, but that standards and duplicates are impossible. Some lines of work, such as jobbing and repairing, offer but little, if any, chance to develop interchangeability. The other essentials above mentioned apply, however, and are perhaps even more necessary in the latter kind of work than in some others. A tool room should be divided into two distinct but adjacent sections, under

FIG. 21.—Maintenance section of tool room of the Ferracute Machine Company. Here tools are made and repaired.

the same head—the tool room foreman. One of these sections should be devoted exclusively to the making and maintenance of tools. Here are employed the tool makers, together with the other workmen required for the upkeep of the factory's tools, etc. All machines, such as tool room lathes, planers, millers, grinders, etc., are located in this section. The men employed here have nothing whatever to do with the storage or handling of tools, etc.

They are not even permitted free access to them for their own use, but must get them from the storage section on check, in exactly the same way as do all other shop

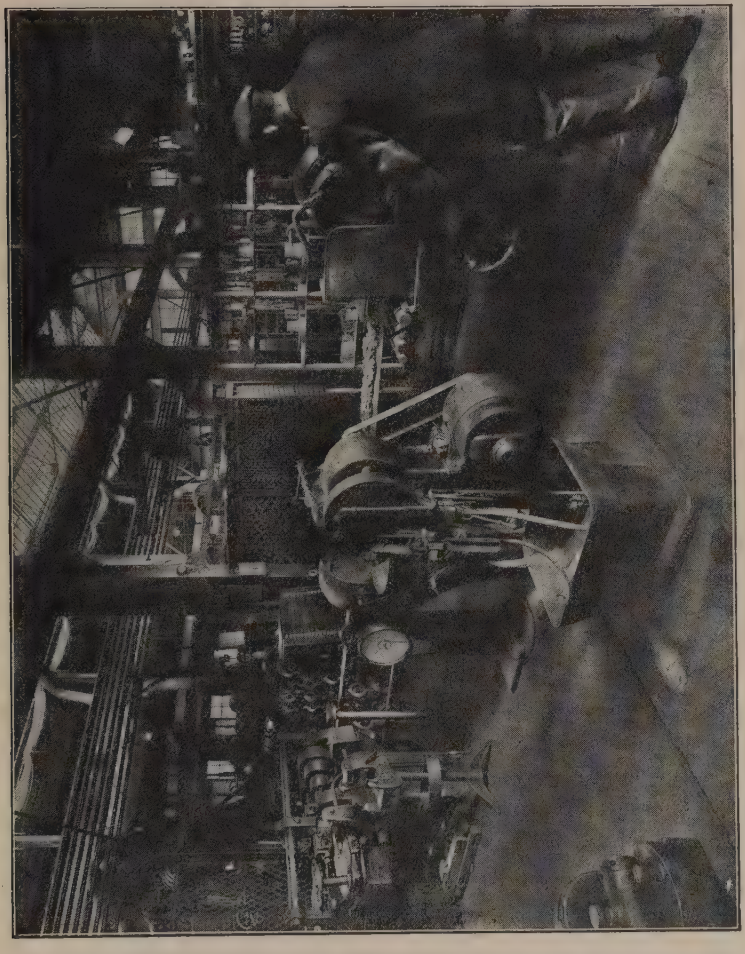


Fig. 22.—Storage section of the tool room of the Ferracute Machine Company.

employees. Fig. 21 shows the maintenance section of the tool room of the Ferracute Machine Company.

The storage section, shown in Fig. 22, is devoted entirely to the storage and care of all tools and is in the direct charge of one man, known as the tool keeper. It is this man's duty to deliver and receive tools only on check at

the time the transaction takes place. He must inspect each tool received from an employee and not return it to its assigned location in the tool rack unless it is found complete, in good order and ready for use again. If the tool needs sharpening it is placed on the shelf adjoining the first section of the tool roon mentioned above. This shelf is adjacent to the tool, drill, and cutter grinding machines, which are in charge of one man. This man is held responsible for the prompt grinding and return of tools to the storage department of the tool room. If a tool is returned from the shops in a broken, incomplete, or abused condition, it is the duty of the tool keeper to report at once to the tool room foremen, presenting, at the time of such report, the tool referred to. The tool room foreman immediately takes steps to repair or replace the broken or misused tool, records the name of the man responsible, and makes a memorandum of the extent of the damage. This report is forwarded by him to the shop foreman or gang boss, who takes steps to prevent a continuance of the damage. A record is kept of the damages to tools by each man separately so that abuse or unusual breakage of tools can be traced to the individual and measures taken to stop it.

The tool room foreman is another functional foreman and has charge and control of all tools while in use. He has the authority, and it is one of his duties, to see that tools are properly used by the shop men, no matter in what department they are, or whom they are under. This enables him to prevent much abuse of tools which would otherwise happen. His work does not in any way interfere with the foreman or gang boss whose men are using the tools, any more than does the functional duty of the inspector, the speed boss, or the move material boss.

Standards in tools are of the first importance, and here is where some quite radical departures are made. In the first place, the average shop will have in use from one to several hundred different shapes of tools, when but one-

quarter (or less) of this number is really required. Each workman has his own favorite way of grinding tools and he feels that unless he can have a tool of a certain shape he cannot satisfactorily do his work. On the contrary, he can do his work better and faster if he has correctly ground tools at hand and in sufficient quantity, because (1) he has a tool properly tempered and ground, which will remove the greatest amount of stock with the least power; and (2) he loses no time going to and from the grinder and grinding his tools himself. Workmen, as a rule, do not know how to grind high-speed steel, and more injury is often done to one of these tools at the grinder than under a cut. First-class tools can easily be made worthless by careless grinding. Less investment is necessary with a properly organized tool room, which issues tools, etc., on check, than where each man has his own assortment. The high cost of high-speed steel makes its general use almost prohibitive under the old methods.

All the required shapes of cutting tools are charted and the correct angles determined. All of a certain kind of tool are always ground to exactly the same angles on a special tool-grinding machine. These tools are kept in the tool room and issued to the men in the required assortment, in some cases several of a kind, depending on the job for which they are to be used. This same plan is followed for special tools and milling cutters. The theory is that certain tools are required for a certain job, and as this job may not always be done by the same man, the tools should be quickly available from a central room and not scattered all over the shop. A much larger stock of tools would be required, as stated above, were each man allowed to keep his own, some of which he would seldom use. High-speed steel at seventy to ninety cents a pound soon runs into a large sum—much too large to permit of its use unless the tools and methods are under perfect control. Lack of proper tool room methods and facilities, and the absence of standards are responsible for the con-

ditions found in many tool rooms and shops. The workman at first opposes the scheme which takes away from him the privilege of grinding tools to his own ideas and shapes. This objection soon wears away, however, under the proper instruction and when working on a bonus, especially when he realizes the time he would have to spend to do his own grinding, and the loss of time caused by his taking his tools to the forge to be dressed as formerly. A tool room man with a special grinder, working to charted instructions, can keep a whole shop supplied with tools at but a small fraction of the expense incurred under the old method. This feature is also responsible for considerable increase in production, due to the fact that *each machine is kept running almost continuously.*

Shelves, racks and other fixtures are necessary so that a definite place can be provided for each tool or jig. Each of these spaces must be tagged or marked with the symbol of the tool which belongs to it. A hook is also provided on which the workman's check is hung at the time the tool is issued to him. If the double check system is in use, then the tool room check with the man's number is placed at the rack and the man's check is hung on one of the two hooks on the tool check rack. This rack provides two hooks for each man, on one of which are kept ten checks; these checks are different from those issued to the men so they can easily be identified as tool room duplicates. As fast as a tool is issued, the man's check is hung on the second hook and one check is taken from the tool room rack and hung at the rack from which the tool was taken. In this way it is possible to tell at a glance how many tools are issued to each man. Everything should be arranged so as to make all tools easy of access, so that a minimum of time and effort is required to issue each tool; general inspection of tools is also facilitated.

Machines of like type and size should be grouped together. As fast as possible they should be speeded alike so that one set of standards for speeds, feeds and cuts

can apply to as many machines as possible. This plan not only balances the capacity of each group of machines (and sometimes a whole department), but reduces to a minimum the clerical and supervision work. Costs of repairs and maintenance are also affected, and the shutting down of one machine due to necessary repairs or other cause is not so apt to tie up or seriously affect production. In other words, the less the variety in equipment, the better the control and the greater the efficiency. Much can be accomplished, however, in the way of increased efficiency, before any great expense is incurred in standardizing existing equipment. The ideal is never lost sight of for a minute, but, as will be explained later, the author believes that we should always get the most out of what we have. This can be done in such a way as to permit of alterations as opportunity or finances allow, and as the conditions change the instructions and time allowances may fairly be changed also. A bonus price once made, however, will never be changed unless the piece, methods or tools are changed. This point will be discussed further in the next chapter.

Although the foregoing treatment of this subject has been devoted mainly to the machine and allied trades, it should be clearly understood that the methods are applicable to any branch of business. Some lines do not require tool rooms, machines and the like equipment, but they do require an equivalent of some sort. Office work, to be efficiently carried out, must have proper and correct standards. Equipment must be maintained and methods must be absolutely controlled. The greater the proportion of manual labor involved in the operation of a business, the more opportunity there is for the application of these methods. The author recently made an investigation and report for a large company which employs several hundred men and women. The business is one which by its character requires intermittently intense effort and exacting service, while at other times of the day the *personnel* is largely

inactive. Comparatively slight alterations in some of the mechanical arrangements of one department and the standardization of its methods, combined with systematic and careful instructions and training for nearly one hundred girls (nominally under another department head, but employed between two departments), would increase the efficiency of both departments.

The main trouble with the majority of departments operating chiefly by manual labor is the lack of correctly determined standards for every move. The solution is motion study, combined with standardized equipment and methods. (See 7–A and 7-B.) These standards should include all the elemental operations incident to the equipment, including machines and other kinds of tools. A big step in the right direction will be taken when all machine tool builders (preferably through the Machine Tool Builders' Association) develop and publish a correct set of standard elementary times. This record should be compiled under one cover and include all types and sizes of machines of all makes. The author hopes to see this same scheme extended to embrace other branches of the trades.

6-B. The Development of a Manufacturing System

The possibility of developing a manufacturing system is considered remote and often impracticable in many lines of business. This is but natural, when there is a lack of definite and authentic records upon which to base calculations. The preceding chapters have dealt with the methods employed to determine accurately what, when, and how product is being handled, and in what quantities. These records also act as a check in many ways on the detail of the business, both as to efficiency and the general policy. The result will be that a careful analysis of them will often show up some rather startling exceptions to what has been the general impression of conditions. It will be found, for example, that some parts are in continual

demand, in greater or less quantities; the reverse will also be true in other cases. Sales records will show business gained or lost due to being with or without certain stock. Deliveries may be unnecessarily long, so that repeated inquiries result in the business going elsewhere. Repair orders for certain parts will indicate that they are the chief source of trouble, and the design should be improved. In other words, accurate records are absolutely essential to the up-to-date management of business, without which its growth is stunted and competition will hold the business elsewhere. The gradually accumulated knowledge of many men should be on record for the use of the firm, and not in incomplete and disconnected form, chiefly in the minds (or private memoranda) of one or more individuals in the company's employ.

The sales department records above referred to, combined with the stores record in the planning department, will enable the management to anticipate a certain amount of new business which, combined with that on order, will assist in the development of the manufacturing in lots. To be sure, the lots may be small as compared with the figures often associated with the term "manufacturing." The fact remains, however, that a large economy can be realized in even small lots, say, five and upward, especially when large work is the rule.

To carry this plan out in a plant making a wide variety of types and sizes of product, it is necessary to keep an up-to-date analysis of all work on order. Similar parts should be brought through together. Until the plan is worked out and the methods are in good working order, there is no doubt that some orders will be delayed by this method; at the same time the others will be greatly expedited. Eventually all work will be coming through the shops much faster, and the delivery dates named on new or prospective work will be greatly shortened. The repeated hurrying of each order by itself, regardless of similar or like work, is expensive and greatly limits the

productive capacity of the shop. The clerical work is also greatly increased, due to the continual duplication of records and a certain delay in getting them out for repeat work in quantities of one or two, when one set of records could often be made to cover a considerable quantity. A great deal of patient " coaching " is required to teach the incumbents of the new positions all the possibilities in this connection. When they have once mastered these points, however, results immediately become very pronounced. At first there is often a tendency to form a " cross circuit " so to speak, or, in other words, to adopt a short cut rather than follow the regular routine, ostensibly to save time. The fact is overlooked that this short-cut method is the old way, which might apply to one or two items (especially if cost of production is to be ignored), but will not apply to the work as a whole without increasing cost and slowing up the whole output. The very object of the new system is to avoid and keep away from just this condition.

It is difficult for some minds to realize that stock work is, after all, the important item to follow, and should not be left as a nest egg to work on when nothing else is at hand. Great congestion has been traced more than once to the fact that stock parts had not been touched. An investigation of nine cases out of ten where delay is claimed to be caused by stock lots that cannot be broken up, will show that the material has been in the shops for weeks and months. During this same period there have been many opportunities to get the work done without in any way interfering with other work. Systematic planning, routing and "dispatching" as described in Chapter IV, will remove these delays.

The development of manufacturing methods results in gradually making more and more parts for stock rather than for individual orders. This is particularly true of many small parts, in many cases used more generally than are the larger ones. In bringing about this change, stock work must be considered as of equal importance to " order

work," as eventually the latter will be more or less dependent upon the former; hence the importance of scheduling and following it up for definite dates of completion in exactly the same way as is done with work on order. A previous chapter referred to the methods by which the quantities to be made for stock are determined and regulated. Batches (or lots) should be as large as possible (other conditions permitting), consistent with processing in a reasonable length of time, or in time to meet requirements of work on order dependent on any of such stock parts. If these points are considered, there will be no need of breaking up stock orders. This should be absolutely avoided.

6-C. The Handling of Erection Work

Oftentimes parts reach the assembling floor and then remain there supposedly in process of erection for days or weeks. A gang of several men are at work on the various pieces, scraping, filling in and fitting. All seem to be busy, but the machine does not get finished. Investigation shows that a certain piece has not yet been received; again, it may be found that a change of specifications has been overlooked, and a number of parts are not yet finished—perhaps the material even has not been ordered, or, if so, it is not yet in the shop. Time is going in on the job, however, and some one has to pay dearly for such inefficiency.

One of the greatest handicaps to the efficient assembling of parts and a cause for the often limited output of the erecting department, is the non-completion of all parts at one time or prior to the time assembling is scheduled to commence. Unless all material for an assembling order is ready and properly arranged in the racks, and on the floor at the time the work is commenced, it cannot be economically and expeditiously handled. A previous chapter dealt with the means employed in routing and following parts in process preparatory to entering stores or the final operation of fitting up and assembling. Prior to

commencement of work on an erection work order, the parts required are drawn from stores in accordance with the stores issue, material list and move order issued from the planning department for that particular job. If the parts required have been made specially for the order in question, they are put in a section by themselves pending the time they will be required on the floor. In the latter case, the time expended on work orders for the processing of them is charged direct to the job and the various pieces do not pass through the stores account at all.

The erection floor is provided with shelf racks on which the parts are placed in proper order by the move material boss at the time he delivers the material to the floor. Under these conditions an erecting gang can accomplish twice as much work as under the old conditions where pieces are delivered to them in driblets and then only after annoying waits and delays. On some classes of work, especially those requiring a large number of pieces, the condition last mentioned is often responsible for enormous erecting costs. Careful inspection of all pieces during their processing is of prime importance. Next to this—and it should be emphasized—comes the completion of all parts on time, so that the work once started can go on without further interruption or delay until it is entirely finished.

Preparatory to erection, the work scheduled for the floor should be properly mapped out and graphically shown in the form of a chart; Fig. 23 shows a chart for the last ten days of June, 1911, for part of the erecting floor force at the Ferracute Machine Company. This work was all planned out ahead and the different gangs made up, to each of which certain machines were allotted. The time allowed for the assembling of each machine is represented by the area opposite each group of men. Allowance is made for the difference in output of the different groups. This chart has to do solely with the floor (or gang) output, based on erecting times as a whole, with a generous allowance for contingencies, and has nothing whatever to do with

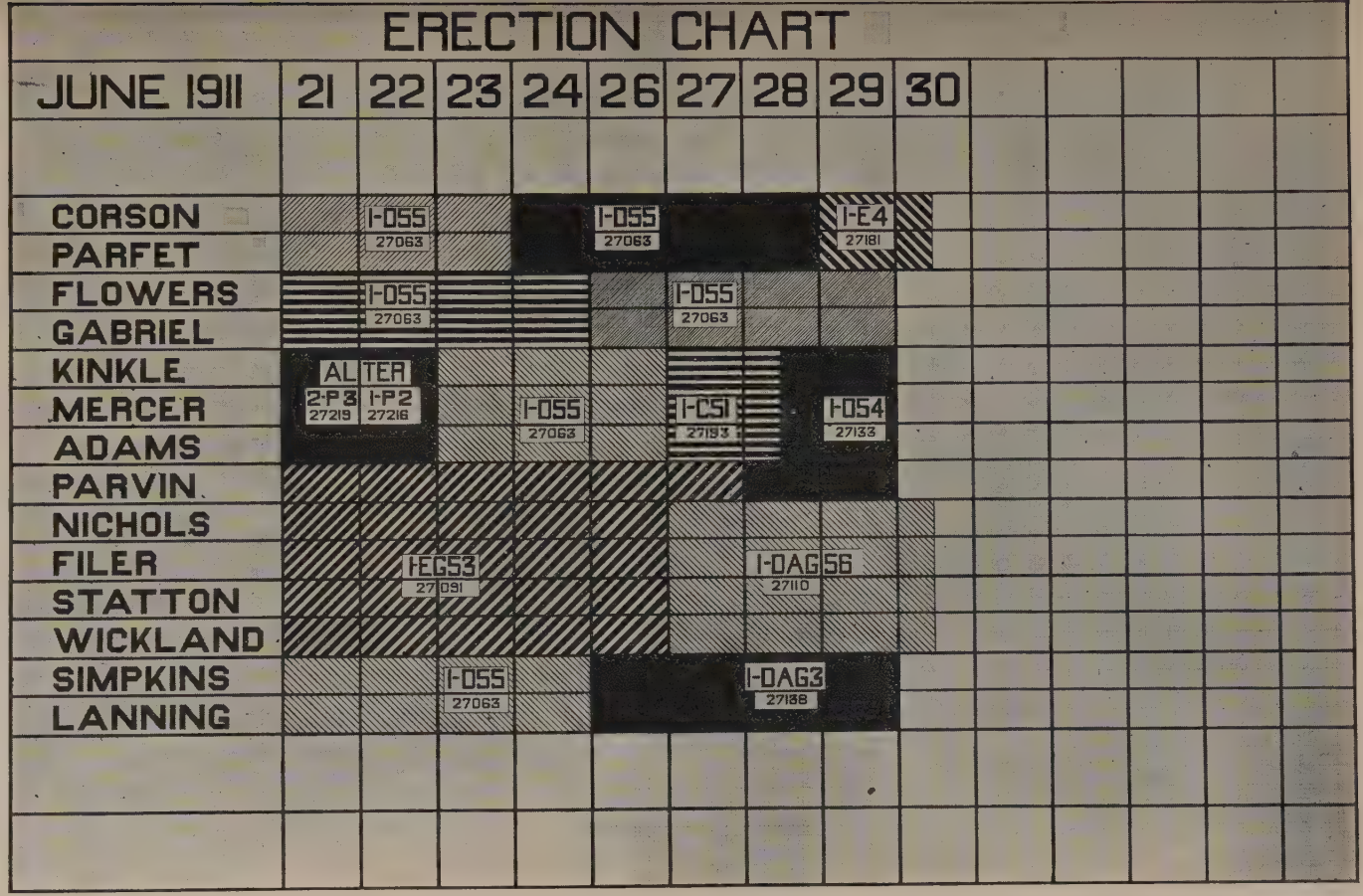


FIG. 23.—Erection Chart, showing graphically work to be done. The shaded areas opposite each group of men represent the time allowed for that job to be in process of erection.

the bonus or standard time allowed for the job. The standard time, however, is the basis on which the allowances shown on the chart are made. Here again we must depend on the accuracy of our records. The planning is all based on actual standard records, not on the judgment of one or more men. The work planned as shown on chart in Fig. 23 was all finished and shipped on time, without a hitch and without night work. Apprentices are not included here, whereas their time is included in the bonus hours for the job, as will be explained in a later chapter.

Referring to the erection chart, Fig. 23, it will be noticed that Corson and Parfet are allowed collectively but sixty (60) hours for the first D55 press, whereas they are allowed eighty (80) hours for their second one. The reason for this is that the first one was started on the morning of the previous day, June 20. Flowers and Gabriel are allowed eighty (80) hours for each of their presses, D55, as are also Simkins and Lanning for their D55 press. This shows the nominal rating of these three groups of men to be the same on this class of work. On the other hand, Mercer, Kinkle and Adams are allowed ninety hours for the same machine because they are less experienced and require more time on this kind of work than do the other gangs. The actual time consumed for erection by the above men on the lot of six D55 machines averaged sixty-nine (69) hours; this time does not include the five hours' running test which is required for each machine before shipment, making a total of seventy-four (74) hours average per machine. According to the chart, Parvin, Nichols, Filer, Statton and Wickland commenced assembling the 1-EG53 on the morning of June 21 and were due to complete it the night of June 26, except that Parvin was to work on it alone June 27, adjusting it for and supervising its test; a total of 260 hours. On the morning of June 28 he (Parvin) started work on the one D54, Mercer, Kinkle and Adams joining him on this job at noon of the same day. It will be seen that this part of the month's work was planned for

completion by the night of June 29 (except one E4 and one DAG56), leaving one day's leeway for unforeseen delays.

The original charts are 24×36 inches, framed under glass, and are hung on the wall of the assembling floor in

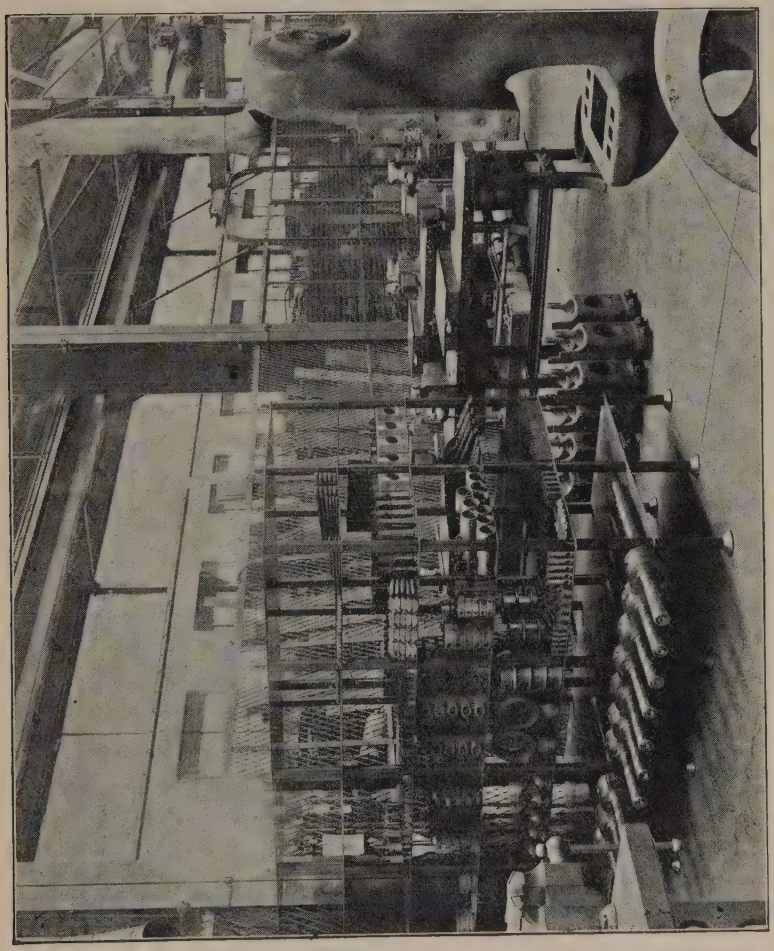


Fig. 24.—A lot of ten machines ready for the erecting force. Small parts are systematically arranged in racks in a predetermined order.

plain view of all. Copies of this chart are also hung in the planning department and the managers' office. Every one having to do with the work charted is thus able to tell at a glance what is due for completion, when it is due, and who is responsible for each machine. The area repre-

senting each different machine is colored differently from its adjoining areas, the bright colors aiding in the graphical effect desired. In making the copy of the chart herein reproduced, black and cross-hatching were used on account

Fig. 25.—Another view of the job shown in Fig. 24.

of the impracticability of reproducing in five or six colors. These charts are issued from ten days to six weeks ahead, from the planning department, although the superintendent is directly responsible for and approves each one. These charts are of particular value to the shipping clerk planning

for cars well in advance; delays of this kind are practically unknown and results are obtained with a minimum of labor and trouble on the part of the shipping clerk. The erecting foreman knows exactly what work he has ahead at all times; he has plenty of time to see that the next job is ready for each gang *before they are ready*. Charts of this kind, which represent time graphically by areas, are of the greatest value and can be put to almost unlimited use.

After the jobs are planned for (and the hours allotted) as a whole, all the material is moved to the different sections of the floor and arranged there in a specified way, or stored away on the shelves provided for the purpose. Figs. 24 and 25 show part of an erecting floor with a job ready for the assembling gang. This arrangement has previously been studied and tried out so as to have all parts as convenient as possible, so that a minimum of lost time for handling is the result. Each gang is restricted to a certain but sufficient amount of floor, rack and bench space. Ordinarily an average-size press will be erected by two men and a boy, providing the hours required for its assembling do not necessitate its being on the floor for more than three or four days at the most. If the machine is rather large, more men are allotted to it. In exceptional cases of large machines, which require from 600 to 1,500 hours to assemble, the gangs are much larger, as otherwise the elapsed time required on the floor in these cases would prolong their completion. Large machines also permit of more men being worked to advantage at one time.

It is a mistake (except perhaps in isolated cases) to work more than two to six men and boys on one job in a gang on bonus. The individuality of the men is lost and no one in the gang can work to the best advantage for several reasons; chiefly because men vary in capacity, when in too large a gang all are not congenial, are apt to be more or less jealous and antagonistic, or feel that each one is not doing his share and hence holding the others back. Work which can be done by a large gang must be so divided into

sections that each section can be handled as a unit by one or two men. The result is the equivalent of a number of small individual units or jobs which, at a certain stage of completion, are themselves assembled in a short time, and perhaps by a number of men, into the completed machine. In a case of this kind each unit or section is inspected separately as its assembling progresses. The final inspection takes place after the machine is complete and has been tested. This final test varies and depends on the size, type and design of machine, also whether it is a new and untried product, or an established standard. The correct functioning of the machine as a whole is, of course, always included in the final inspection. Inspection of the table of operation times on a preceding page will show what has been accomplished in the way of reduced labor cost for assembling; see operation symbol AS. Many equally good examples could be given in addition to those listed in the table referred to.

CHAPTER VII

7-A. Introduction of Time Studies
7-B. Analysis of Time Studies and the Development of Instruction Cards
7-C. Discussion of Piece-work, Premium, Bonus, Differential Rate and Differential Bonus Systems of Wage Payment
7-D. Method Used by the Author to Compute Differential Bonus

The subject now under consideration will embrace that part of the new scheme of organization for which all previous details have been preparing the way: time studies, instruction cards and bonus. The methods which have been described in previous chapters all have their importance as a part of the whole. They are the "means" by which it is possible to support and maintain that "end" of the system which will be presented here. Time study and rate setting can be successfully carried to completion only after each necessary previous step has been substantially laid. Therefore, the large savings which must inevitably result if the details have been well laid, will come with the installation of time studies and bonus rates.

Many unsuccessful attempts to start piece or premium rate setting have been made. Often the cause of failure may seem to be directly attributable to lack of tact, insufficient knowledge of conditions or total disregard of them. As a matter of fact, not less than 90 per cent of the failures are actually due to the absence of some or much of the preliminary work absolutely necessary to insure the highest efficiency which produces maximum output with a minimum waste. The result is that the natural and usual handicaps which the organizer has to contend with in ordinary cases are secondary only to those found in a concern where an unsuccessful attempt has been made to install scientific

methods. The effects of such a failure are far-reaching, and years fail to wholly remove them. The firm contemplating the installation of modern methods, including bonus or similar incentives for workmen, cannot be too careful when deciding on such a course in choosing competent counsel. When the course to be followed has once been decided upon, and the expert engaged to see it through, the management must be prepared to give the new order of things its whole support. The writer is but reiterating what has already been said in the opening pages, but the the fact cannot be over-emphasized. Old traditions must be met and overcome, but time and harmony will solve the problem.

Many elements are involved that must have the most careful consideration, and too much caution cannot be exercised in the laying of the preliminaries before attempting to set rates. Such a radical change must be carried on slowly and circumspectly. Any appearance of mystery or secrecy must be positively avoided. The object of each new move or change must be made perfectly clear, at the time, to those directly involved. The use of the stop watch is at first liable to arouse at least a mild opposition, unless the way has been properly prepared for its introduction into regular use. The watch is one of the essentials, and to get results with it the men must be gradually accustomed to its use. They must be made to realize that they, as well as the firm, are to benefit financially from its use. In fact, the financial return to the man is forthcoming almost at once and in visible cash; the firm's return, although just as sure, is not at once apparent, neither is it traceable directly and at once to each specific job or line of endeavor as is true in the case of the workman. The use of the watch is necessary to the end aimed for. After the men benefit, however, by such a method, they begin at once to better understand its object. There will, of course, be misunderstandings at first, but we must not forget that they occur more often through the lack of proper instruction

than from a wilful desire to oppose anything new. This is not always so, to be sure, but the workman is too often blamed for what belongs to some one else. At this point in the work, an extensive knowledge of human nature—combined with superjudgment—is absolutely essential. The man responsible must be able to discriminate justly and unfailingly between wilful opposition or disobedience, and a misunderstanding due to ignorance.

A very common criticism of the bonus and time-study system is that "it is all right for some kinds of business, but it won't do here, etc." This is but another case of lack of knowledge of the subject. This same criticism (in effect) was made some years ago in regard to the Ferracute Machine Co. The resulte that have been realized and which are to be further described form the best refutation possible. No rule or definite set of instructions, however, can be given to cover all cases; each one must be worked out by itself, but the fact remains that it can be and is being done successfully. Finally, the work to be accomplished now is one in which the results aimed at, and which will be fully realized in the majority of cases, are ridiculously out of all proportion to what has been. Extreme care must be exercised so as not to make the foreman, gang bosses, or men feel that reflections are being cast on their ability or past methods. Make them all feel that your work is one of instruction and help. Let them fully understand that when the task is accomplished they are all to reap financial reward.

A first-class journeyman is commonly supposed to be efficient and thoroughly accomplished in his particular trade. That this is not so has been repeatedly proven. Mr. Taylor cites many cases as proof; so does Mr. Gilbreth, who has demonstrated that the average mason, when working under instruction cards and bonus, can lay about three times as many bricks in a day as does the average skilled man. This in a trade, too, that is thousands of years old. Mr. Gilbreth's bonus workers lay a brick with *five*

moves, as compared to the average mason's *eighteen* motions. It should be realized that in the past apprentices have been obliged (in the majority of shops) to pick up the knowledge of their trade in a more or less haphazard way, with but comparatively little direct personal instruction from the foreman or bosses. These men had previously learned their trade in the same way. In many cases they probably had poorer equipment and perhaps even less personal instruction. Another very uncertain factor, too, is the number of different ways of doing the same thing in different shops. The average man is a great imitator, and, not being trained to, or under, logical and systematic analytical study of all the elements of his trade, he is naturally much less efficient than he might otherwise be. In the average shop a workman naturally " hits the pace " of that shop. The result has been a decrease in skill and efficiency and a big tendency toward specialization. The result to the workman has been detrimental both morally and financially. The following methods aim to reverse this condition by giving apprentices and workmen the advantages and incentive they should have had years ago.

The writer believes that enployees having the benefit of these methods and working under written instructions are less liable to accidental injury. Although they may be working faster on many classes of work, their minds are on what they are doing, and they are interested in the proper and speedy completion of their work. Surely a man working thus is safer than one who is working listlessly with his thoughts far away, or perhaps away from his machine " visiting " other parts of the shop. Many accidents can be traced to carelessness or ignorance when setting a piece of work; these details are supposed to be thoroughly understood by a journeyman, yet the utmost vigilance on the part of foremen and bosses is often insufficent to prevent an accident. When the majority of shop work is done according to *written instructions*, a big stride has been taken toward the protection of the man.

7-A. Introduction of Time Studies

In making time studies, the " decimal " stop watch is used. This watch has a decimal dial, as its name indicates, the minute or outer circle of graduations being divided into a hundred parts instead of sixty as in the ordinary watch. A small dial registers minutes and is also arranged to stop and start with the thumb of the left hand. If an observation has been taken and the watch stopped, say at 1.75 minutes, it can be started again on a second observation, which adds to the first. If it is desired to throw the hands to zero before taking the second observation, so that *it* only will be registered, a pressure of the forefinger on the stem is necessary. Fig. 26 shows a convenient arrangement for a stop watch of this kind. The board is 10 inches wide by 16 inches long from top to bottom. The clips holding the watch are of thin spring brass, permitting its ready removal, if desired. Time-study forms, Fig. 27, are held in place from the top edge by a " giant clip." The board is held on the left forearm with the bottom edge of it against the body. The thumb and forefinger of the left hand manipulate the watch, leaving the right hand free to write.

The observer, or time-study man, must be a skilled man in the trade under investigation. It is not absolutely necessary that he be the fastest worker in the shop, but he must be one of the best. He must be thoroughly instructed in the duties of this position, and first of all, must be entirely in accord with the new methods. He must take pride in his work and must be enthusiastic. Sound judgment and an unbiased mind are necessary, and above all things, he must be patient, exacting and extremely diplomatic. He will have many opportunities to carry tales and make trouble; this he must absolutely avoid. If so inclined, he must be broken of the habit or removed. He must study his man as well as the job, and he *must* win and retain the confidence of those who come under him. He is a functional foreman in every sense of the

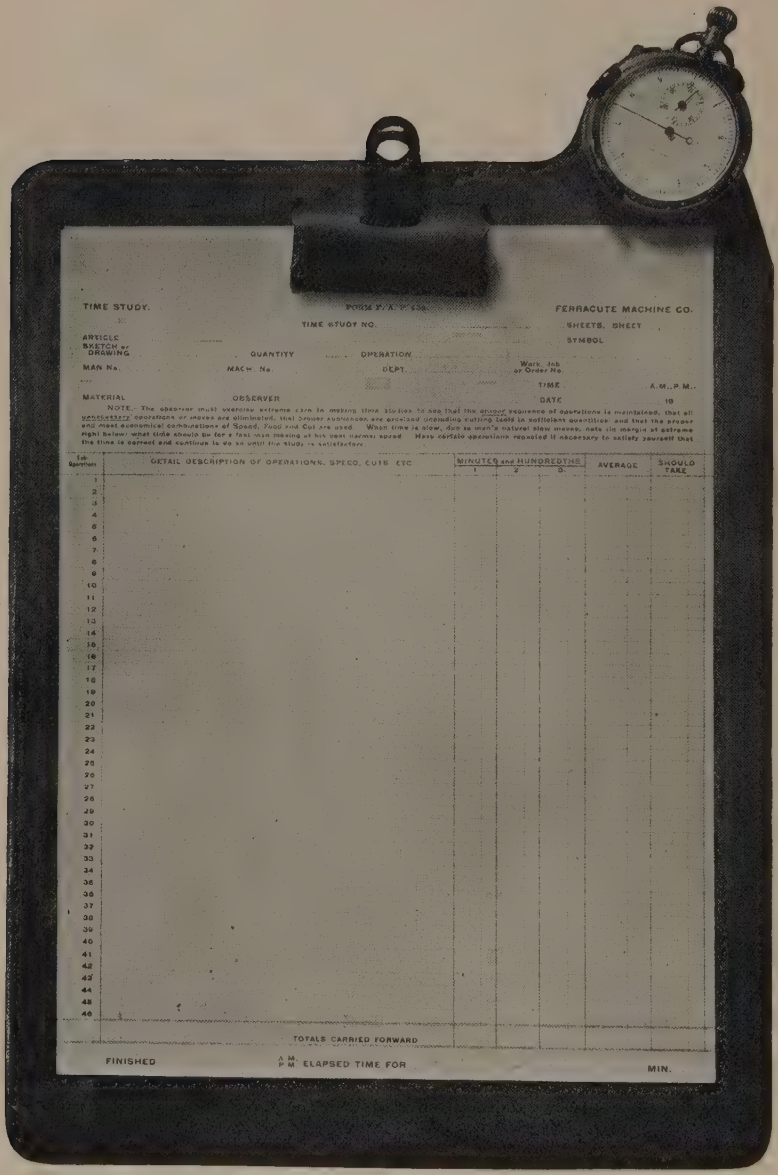

TIME STUDY.
FORM F. A. P. 434
FERRACUTE MACHINE CO.
TIME STUDY NO.
SHEETS. SHEET
ARTICLE
SYMBOL
SKETCH or DRAWING
QUANTITY
OPERATION
MAN No.
MACH. No.
DEPT.
Work, Job or Order No.
TIME
A.M., P.M.
MATERIAL
OBSERVER
DATE
19
NOTE. The observer must exercise extreme care in making time studies to see that the proper sequence of operations is maintained, that all unnecessary operations or moves are eliminated, that proper attendance are provided including cutting tools in sufficient quantities and that the proper and most economical combinations of Speed, Feed and Cut are used. When time is slow, due to man's natural slow moves, note the margin at extreme right below; what time should be for a fast man moving at his best normal speed. Have certain operations repeated if necessary to satisfy yourself that the time is correct and continue to do so until the study is satisfactory.
Job Operation
DETAIL DESCRIPTION OF OPERATIONS, SPEED, CUTS ETC
MINUTES and HUNDREDTHS
1
2
3
AVERAGE
SHOULD TAKE
TOTALS CARRIED FORWARD
FINISHED
A.M. P.M. ELAPSED TIME FOR
MIN.

FIG. 26.—Decimal stop watch and observation board.

TIME STUDY. FORM P. A. P. 45a. FERRACUTE MACHINE CO.

TIME STUDY NO. 106 1 SHEETS, SHEET 1

ARTICLE P3 Ramo. SYMBOL RM93A

SKETCH or DRAWING 10177 QUANTITY 25 OPERATION BO, RM.

MAN No. 37 MACH. No. 38 DEPT. PRE Work, Job or Order No. 21455

TIME 3.7 A.M., P.M.

MATERIAL I.C. OBSERVER Butterfield DATE 7/11 1909

NOTE.—The observer must exercise extreme care in making time studies to see that the proper sequence of operations is maintained, that all unnecessary operations or moves are eliminated, that proper appliances are provided including cutting tools in sufficient quantities; and that the proper and most economical combinations of Speed, Feed and Cut are used. When time is slow, due to man's natural slow moves, note in margin at extreme right below what time should be for a fast man moving at his best normal speed. Have certain operations repeated if necessary to satisfy yourself that the time is correct and continue to do so until the study is satisfactory.

Sub Operations		DETAIL DESCRIPTION OF OPERATIONS, SPEED, CUTS, ETC.	MINUTES and HUNDREDTHS 1	2	3	AVERAGE	SHOULD TAKE
✓	1	Prepare machine.	6				
✓	2	Remove bars from head.	2 25				9 00
✓	3	Place jig.	4 30				
	4	Place work in jig using crane.	1 60	2.			1 20
✓	5	Lay out rams.	9				
✓	6	Set jig to move rams and clamps.	0 15	1 30			12 00
✓	7	Set tools in head and clamps.	1 90				
	8	Bring "Boier" into position.	65	58			48
	9	BO, Roughing cut, speed 55, .047" feed.					
	10		0 35	0 34			0 24
	11	Up head and stop machine	10	20			12
	12	Swing "Upper" into position	58	73			48
	13	BO, Finish cut, same speed and feed.	0 30	0 30			0 18
	14	Up head and stop machine.	10	10			12
	15	Swing Reamer Spindle into position	53	65			42
	16	Lift Reamer from floor and couple up.	60	65			60
	17	RM, same speed, feed .293"	1 40	1 32			1 32
	18	Up head and stop machine.	10	17			12
	19	Remove Reamer.	50	02			48
	20	Unset rams.	05	08			00
	21	Unclamp jig.	15	15			10
	22	Remove work to floor (crane)	50	50			40
	23	Off jig	10	10			10
	24	Clean out jig.	34	30			12
	25						
	26						
	27						
	28						
	29						
	30	✓ = Lot time = 21 minutes					
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
	40						
	41						
	42						
	43						
	44						
	45						
	46						
		TOTALS CARRIED FORWARD	00 82 20 20			24 85	40 48

FINISHED 7.1 7/13 A.M. P.M. ELAPSED TIME FOR 25 = 11 hours MIN.

FIG. 27.—Time study form showing a typical time study. Original is 8½×11 ins.

word, and as such comes in contact, sooner or later, and more or less often, with every workman in the shop. Great responsibility rests with him and he is not by any means an easy man to find. He must be broken in gradually, must not attempt to cover too much ground at first, and above all things he must practise the "square deal." Taking stop-watch observations is not a clerk's job, although the writer has met office men often enough who thought they could do it.

The observer, when making a time study, should be sure to fill in all the information required at the top of the time-study form, as indicated by the printed matter. The substance of the printed "note" at the top of this form (Fig. 27) should *always* be borne in mind. Each job must be carefully and thoroughly analyzed into its various elements. The best sequence of operations, as well as the proper tools, feeds, speeds and cuts must be determined before the study is completed. This is a most important record and must always be complete in itself for later reference.

First of all, there are a great many standard elemental times to be determined and tabulated for use in connection with time studies and instruction cards. These elements occur repeatedly on all work of whatever nature which is done in the different types of machine. Once determined, they represent a standard to be used in the future for that particular machine or group of like machines. In addition to the above, full data must be tabulated covering all details of capacity, power, adaptability, etc., of each machine, maximum feeds, cuts, speeds, etc. Other elemental times are also necessary to the expediting and standardizing of this work; for example, standard time allowances for setting different kinds of work in different types of machines, time required to clamp work with different sizes and styles of clamps and bolts, time needed to raise different weights from floor to machine, both by hand for small parts, and by crane or hoists for larger ones.

Different trades, of course, call for different elemental operations.

All of these elemental times represent a much larger proportion of a man's daily work than any one would at first imagine. Although the classes of work being done in a shop may vary greatly, both in sizes and shapes, a great deal of a man's time is consumed daily in doing the same thing over and over again. This statement applies to getting tools, starting and stopping his machine, setting and unsetting tools, making adjustments, etc. Until an actual record has been made of the time so consumed, and this record compared with the time the same operations should take, as proved by stop-watch observations, no one will be convinced of the true state of affairs. The analysis of new work into its elements then becomes a mere matter of applying standard elementary times to most of the elements and calculating or observing the times for the remaining few.

The writer recently noted a very good example of this fact. A bonus time of 2.3 hours was given for a job which had previously averaged over 5.5 hours. The best record that had been made before the job had been timed in detail was 4.3 hours. Based on several careful studies, the time of 2.3 hours was determined, as above stated. The next time the job came through a good lathe hand was put on it, one thoroughly familiar with the work, but not the man with whom the time study had been made. The best he could do was over 4.0 hours per piece. The man in speaking of it afterward to the superintendent said that he hoped he would not be accused of loafing, for he had worked hard; but if this job must be done in 2.3 hours, as called for by the bonus chart, some one else would have to do it. He furthermore claimed he could not see how the man originally under observation could do the job so quickly. The superintendent made it a point to have the next lot routed to this man, and before he was allowed to proceed, the superintendent and speed boss went over

it with him in detail; he was shown from the very start where he was wasting time, both in the manipulation of his lathe and in changing tools, calipering, etc. The job was finished in 2.2 hours per piece, and this man from that day ranked as one of the best lathe hands. He has since done this work in 1.95 hours per piece, which is the shop record for the job. He has made the statement that he did not know it was in him, or that there was so much to be learned about his trade.

Before starting to make a time study, the right man must be chosen for the job. He must be a fast and conscientious worker and skilled at the kind of work, or branch of the trade under investigation. If such a man is not available, and a "green" man is to be broken in, the observer must demonstrate the various elements as the study progresses. First of all (other conditions being propitious), the man chosen to do the job must be one whose interest and cooperation have been secured and who is strictly loyal and thoroughly in sympathy with the new methods. Having chosen such a man, it is generally good practice to pay him 25 per cent of his hourly rate as a bonus for following instructions and while working under the watch, so long as he continues to conscientiously do the best he can to assist toward an accurate and fair time study of the job in question. After a number of different men have become accustomed to working under the watch, this 25 per cent bonus should be regularly paid to each man when working under these conditions.

It will be somewhat difficult at first to win the operator's good-will and hearty cooperation. When it is made clear to him that there are many elements in the job which can be improved, such as a different way of rigging up the job in the first place, or certain combinations of speeds, feeds, and cuts, and that he has a chance of earning from 20 to 40 per cent more wages under the new scheme, you have then brought home to him wherein he is to benefit. His work will at once become more interesting; hence,

he can do much more work with less fatigue. A man's mental condition and environment are two factors which exert a most far-reaching influence on his output; hence his own and the employer's interest both require that this be given careful consideration. Under these conditions each man is enabled to stand on his own feet. He is assured of the remuneration that is commensurate with his ability. He will not be wholly subject then to a prevailing rate of wages, which in so many cases is most unjust to both employee and employer.

Having chosen the man, the job must be studied and analyzed and the best way to do it determined. This may require much experimenting by trying out one method after another. The tools and fixtures to be used must also be determined and listed so that for future repeat orders the proper tools may be made ready in the tool room and moved to the machine. This should be done in advance of the time the job is scheduled to start. The material already has been moved to the machine, as explained in a previous chapter.

In making a time study, every distinct sub-operation must be timed separately. All time is expressed in minutes and decimals on the time-study form, after which the time is transposed into hours and decimals. Operation times that are too short to be accurately timed individually may be calculated; this may be done by taking the time for say four sub-operations, then by deducting the time taken for three, get the time for one. As the study progresses, all unnecessary time should be noted and deducted. This includes time lost due to a man's too slow movements, waiting for or grinding tools, as well as delays from any other source not necessary to the proper performance of the work. After the work is under way, several time studies from different pieces of the same lot (if there are more than one) should be made on the one form. Three columns are provided for this purpose. In addition the column to the right is to be filled in showing what time is finally

decided on for each sub-operation. Fig. 27 is a typical example of a completed time study ready for analysis, and examination will prove it to be self-explanatory. Eventually all elemental times will be standard and the times shown for them on the time-study form will be ignored except to account for much waste time. The sample time study shown in Fig. 27 is a short one to illustrate a simple case. Ten or twelve sheets are often required for one piece, if it be a large or intricate one. The time study when completed will show all the detail times, equal in amount to the total elapsed time. It must be borne in mind that each study is based on a certain design of piece, made of a certain material, using specified equipment and tools, and is not to apply if one or more conditions are changed. The man, however, is a variable factor. The sixth chapter explains how this is provided for on the bonus chart in the form of a sliding scale within certain limits. These limits will be more fully described further on.

The kind and quality of material has also to be taken into consideration. Cast iron, particularly, is liable to a great variation between different kinds, shapes and sizes of castings. Certain foundry practice and inspection will eliminate a big percentage of the trouble met with in ordinary shops. If a time-study and instruction card allows 75 feet per minute as a cutting speed, and an unusually hard casting will not permit of over 50 feet, an allowance will be made to meet the new condition. The difference in quality of the material is beyond the control of the man, and if it prevents his earning a bonus, the management must expect to make an adjustment. No allowance, however, is to be made for delays in manipulation of the machine, work or tools. A shut-down of the machine for adjustment, cleaning, or minor repairs, will not be allowed unless it is shown beyond question that these delays were in no way due to the operator. In some cases, however, the job may be stopped, due to any of the above-mentioned delays, and the operator put on other work. When the

job is finally resumed, the total time elapsed while it was being worked on is used in determining the time per piece. It is up to the functional bosses to see that the machine and equipment are in proper shape *before* work is started on any job.

In addition to the decimal stop watch, there are other

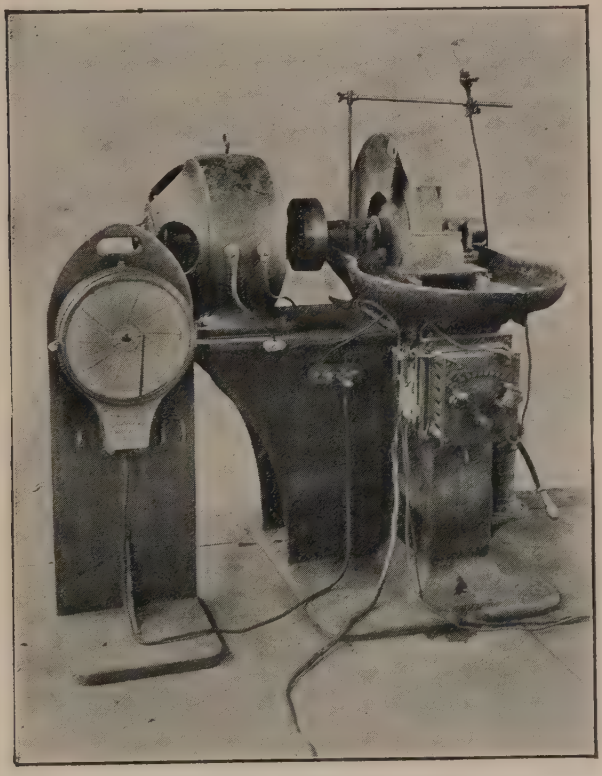


Fig. 28.—Bristol recording horse-power meter. Note the portable stand, making it convenient to move from one machine to another.

mechanical aids to assist in the quickening of the work of investigation. Among them are the Barth time and speed slide rules; by their use a few seconds will suffice to determine the time any given cut will take at a given speed and feed. A speed slide rule adapted to any one machine will

give instantly the driving speed most available for a given cutting speed.

The Bristol recording horsepower meter is another

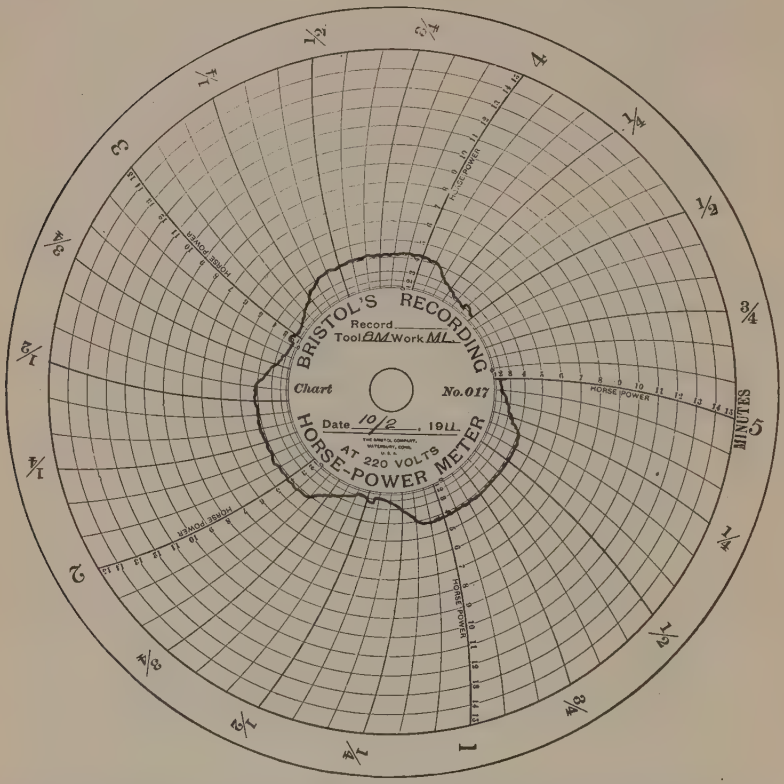


FIG. 29.—Horse-power chart taken on a gear cutter, showing the record of three consecutive teeth on a 90-tooth, 3-pitch gear. With 5-inch face.

MATERIAL—Special, hard, high-manganese iron.
CUTTER—High-speed steel, 4⅛ inches diameter, 10 teeth.
SPEED—92 revolutions per minute.
CUTTING SPEED—99 feet per minute.
FEED—4.75 inches per minute; 0.0051 inch feed per tooth.
COOLING MEDIUM—Air blast.

instrument of great value in determining the power consumed by any electrically driven machine for different sizes of work at different combinations of speed, feed, cut, etc. Fig. 28 shows a convenient arrangement for this

instrument to enable it to be easily transferred from one motor-driven machine to another. A hairpin connection is provided to permit of instantly making the electrical connection. Data given by this chart (see Fig. 29) form one basis of determining the limits to which a machine may be driven. The gear slide rule will quickly show the safe working stresses to which it may be subjected without injury. If the power available at the machine is not sufficient to operate it at its safe maximum capacity, the drive should be changed. These mechanical aids prevent much undue wear or undue breakage.

7-B. Analysis of the Time Study and the Creation of the Instruction Card

The instruction card shown in Fig. 30 represents the final record or standard for the operation or job. This instruction is made up from the time study (Fig. 27) after it has been analyzed into its various elements, unnecessary moves eliminated and standard elemental times substituted where known. Sub-operations 1, 2, 3 and 24 represent "lot time" and are, of course, the same whether one or more pieces are being made. Each sub-operation is numbered and the instruction, as shown, covers every move, or set of moves, necessary to complete the entire operation from the time the piece is taken from the floor until it is returned there. The speeds, feeds and cuts are all determined and tools to be used specified for each. The jig or fixture used (if any) to hold the work is also referred to by symbol. The operation illustrated in Figs. 27 and 30 averaged 1.85 hours under the old day methods. After time study, and under bonus, it has been done repeatedly in 0.45 hour or less (see table of operation times, Chapter VI, opposite Chart No. 10).

It must not be assumed that it is always an easy matter to get a sufficiently accurate time study, and hence a good set of instructions. In point of fact, time studies sometimes

INSTRUCTION CARD — Form F.A.P. 35 a — FERRACUTE MACHINE CO.

NOTE: All time is expressed in Hours and Decimals.

INSTRUCTION 10

1 SHEETS, SHEET 1 DATE Oct. 19 , 1909

ARTICLE OR JOB RM93A

OPERATION BO and RM

Quantity 20 | Material I.C. | Hand or Machine 3B | Sketch or Drawing 10177

TOTAL LOT TIME 45 | TOTAL PIECE TIME .35 | BONUS CHART 10

SUB OPERATION	DETAIL INSTRUCTIONS	TOOL	CUT	FEED	SPEED	PIECE TIME	LOT TIME
1	Preparation						200
2	L.O. first cause						050
3	Set jig by first cause & clamps						104
4	Place work in jig & clamps					020	
5	Swing tower to 1st position					007	
6	Start machine					001	
7	Change feed					001	
8	BO		.156"	.047"	G5	103	
9	Stop machine & raise head					002	
10	Swing reamer to position					007	
11	Start machine					001	
12	BO		.059	.047"	G5	103	
13	Stop machine & raise head					002	
14	Swing reamer shank to position					007	
15	Couple reamer to shank					009	
16	Start machine					001	
17	Change feed					001	
18	RM		.0035"	.293"	G5	021	
19	Stop machine & raise head					002	
20	Uncouple reamer from shank					008	
21	Insert cause					010	
22	Place work on floor					010	
23	Clean out jig					002	
24	DM and clean machine and						
25	change work order						100
26							
27	Add 10% to piece time					032	
28							
29							
30							
31							
32							
	Carried Forward, or TOTAL					350	450

WHEN MACHINE CANNOT BE RUN AS SPECIFIED, CANC BOSS MUST REPORT AT ONCE TO P Meyers.

INSTRUCTION 10

FIG. 30.—Instruction card for shop use. Original is 9×12 ins. These are issued from the tool room in the form of blueprints.

have to be made at different times from several successive lots or jobs before a satisfactory instruction card can be issued or a bonus rate set. The time-study man must often spend several consecutive days on one job before he can get a satisfactory study. When this has been obtained, however, it is a comparatively easy matter to write up the instructions. These instructions, then, form the permanent standard for that operation, until a change in one or more of its conditions necessitates a new one. The record in itself looks simple, but the preliminary work involved can be only appreciated by one who has been actively engaged in this kind of work. The reader must not be misled into thinking that after a satisfactory time study has been taken and the instruction card made out, there is nothing more to be done. As often as not, this point marks the beginning of a more or less lengthy period of patient and systematic coaching. In the first place, several different men will likely work on as many successive lots. Until these men have been thoroughly accustomed to bonus work, they will not perform the operation as fast as they can eventually. This is true also of machine operators who perhaps run the same machine from one end of the year to the other, but on many kinds of work. Most men are more adept at one class of work than they are at another, even though it is performed on the same machine. Again, their mental attitude must be considered. They think that although they can earn ten or twelve cents an hour bonus on one job, they can make nothing on some new job. All these conditions and differences of opinion must be met and the employee instructed until he becomes proficient on each job put to him under bonus. This method also results in placing men at the work they are best fitted for. They cannot continue to work inefficiently for perhaps years when they should have been on other jobs or working at some other trade. The writer has in mind a number of jobs which took from six to fourteen months of intermittent, patient

labor on his part before a cent of bonus was earned on them. This need not be wondered at, especially in a case where a bonus chart commencimg at 400 hours was issued for a job that had previously never been done in less than 1,095 hours. In the case just cited, it was particularly slow work, as it was a "gang" job, and many of the men at first believed it absolutely impossible to get down to 400 hours (when the bonus commenced), to say nothing of getting to the 25 per cent bonus mark of 285 hours. After a little more than a year had elapsed, however, and each successive lot was done in quicker time than the previous one, interest was aroused, and the first bonus was finally earned. This averaged about 5 cents per hour per man. They then realized what could be done, and a steady improvement has been made since. On the last job, one recently finished, the time of 246.7 hours was realized. The bonus on this time is $27.075, or an average of nearly 11 cents per hour. This is bonus chart 16, referred to under 7-D.

To bring about this result, each job was carefully planned out and the men carefully selected. As the work progressed, wasted time was noted, speeds were kept up, false moves eliminated, etc. The gang boss was kept posted every few days as to the hours being consumed on the job. In fact, everything possible was done to help the men and assist them to successfully accomplish the task. Methods of handling material systematically were refined; material was ready when wanted, and kept arranged so as to be available with a minimum of effort or delay on the part of the worker. The individual men were studied and so placed that their efforts were most efficient. The job was divided into two distinct parts, each under a gang boss who was responsible for his part of the work. Both of them were responsible to the foreman, who saw to the proper completion of the job as a whole. The number of men that could be most efficiently used on the job was also studied and the scheduled completion of each lot of

machines is based on this number, which is not to exceed ten at any one time, although more than this number may work on it before the work is finished. The machines are built in lots of ten. Based on 247 hours each, we have a present processing time for this quantity of 2,470 hours, which for ten men means about 25 working days, or at the rate of one lot (of ten machines) every month. Compare this with the old rate of nearly 11,000 hours on this part of the work for ten; a production ratio increase of over 4.4 to 1.

Similar methods in the way of handling preliminaries and in supervision apply to all bonus work until the men are trained to the quick and satisfactory performance of their tasks. It can readily be seen that more depends on the efficiency of the organization than on the men's individual efforts. These preliminaries in the way of development and maintenance of the new type of organization must, of course, cost the firm considerable before these results are obtained. This fact must not be overlooked (and it is too often overlooked) when comparing the bonus realized by the men with their wages to the production increases and cost reductions. The investment made by the firm is responsible for a big percentage of the difference and involves no extra effort on the part of the men. The intention is to pay the employee generously for his share in the results obtained. Very often the greatest proportion of the gain is due to factors entirely beyond the influence of the individual. In such cases he should have no share in the gain in way of a bonus. In other cases, where the saving is largely up to him, he should be generously paid extra in proportion to his influence in making such saving. Some critics have not yet been able to see this point, but it is true nevertheless. I was recently told of a case in which a high-speed-steel tool was used for the first time. The tool was provided for the job and the correct cutting speed determined for the particular work in the machine. The result was that the speed was twice

as fast and the operator immediately demanded a 100 per cent increase in his wages. It was, of course, refused, and the man quit without notice.

To further illustrate this point let us take a concrete example. We have a gear-cutting machine in use, in good repair and operating daily, doing a satisfactory quality of work. With this condition we determine, with a stop watch, a fair, yet fast, time for the manipulation of it by the operator. This includes the setting of the gears for indexing, speed of cutters, feeds, etc., also time for setting the cutters and work, and cutting the first one or two teeth. Obviously, the man should be well paid for living up to instructions, keeping his machine in good order and turning out satisfactory work. The time mentioned above, however, represents perhaps but one-tenth or less of the total time for the cutting of all the teeth. The machine runs for four or five hours with practically no attention, automatically doing its work, while the man is busy with other similar machines, or operating an adjacent machine of a different type. Now, to go a step further, time study determines a best speed and feed for the cutters and the operator is instructed to use these speeds rather than those he has been in the habit of using. The result is that gears will be cut in say 50 per cent less time than formerly; 10 per cent (or less) of this cut is due to the operator working (intermittently) at his maximum speed, and the balance, or 90 per cent of the saving is due entirely to the changes made by the management, including a higher speeding of the machine—changes with which the operator had nothing to do whatever, and which entail not one foot-pound of work on his part. In this case, an actual record, which may be taken as one extreme, we have a cut in labor cost for the job of nearly 50 per cent with only a small part of the saving going to the man, for the reason explained above.

Another good example can be given of a job on the assembling floor; a crank shaft is being fitted to the frame

of a press. There is required for this operation but 0.25 hour for two men, as compared to from six to eight hours, as formerly. This is due entirely to the fact that the frame is bored by a different method, on a different machine, and the hole is finally reamed to the nominal size with a tolerance of 0.001 inch; the shaft is ground accurately to within 0.001 inch of a definitely determined size, which is a few thousandths less than the nominal dimension of the hole. The result is an accurate and smooth bearing and an equally accurate and smooth shaft journal with a proper allowance between the two for a running fit. No scraping or hand work is necessary. Formerly the drawings required no definite limit of accuracy and the parts varied both in accuracy and alignment and quality of finish. A great deal of hand fitting and scraping was necessary not only to bring the parts into proper relative position and fit, but often to get the required surface finish; hence the labor wasted in doing over by hand what was supposed to have been already done by machine. Here again is another case in which the saving made was due entirely to conditions beyond the control or influence of the men on the erecting floor and involving no labor on their part. Hundreds of similar ones could be given. Under these circumstances it will be seen that there is no injustice to the man, for instead of working twenty to thirty times faster, as would appear on the surface, his speed is no greater and he is actually exerting himself less.

The above examples illustrate one extreme wherein the production increase is all out of proportion to the comparatively slight increase in the man's wages, a point much harped on by certain uninformed would-be critics. Now to take the other extreme. Let us take a purely manual operation, such as fitting up the parts for, and assembling a complete machine on the assembling floor. In the first place, the material is provided in the correct quantity and is piled ready to be worked on before the workman has anything to do with the job. The machine work is under

better control, chiefly due to proper drawing and inspection. Clearances are allowed for; patterns have perhaps been altered to reduce the labor of chipping and fitting. Certain troublesome cored holes have perhaps been enlarged or done away with; in the latter case, a clearance hole is drilled before the piece reaches the floor. Clearances between finished parts are allowed for on all fits, so that hand filing or scraping is reduced to a minimum, except where scraping is necessary to get a suitable bearing.

So far the assembler has done nothing on the job, and therefore has had nothing to do with the preliminaries which have done so much to make his part of the job a great deal quicker and easier. This saving has been made in other departments, and that part of this saving due to the efforts of other workmen has been paid for in the form of a bonus. These preliminaries are often responsible for an assembling time being reduced 50 per cent or more with no extra effort on the part of the assembler. From this point on, however, the reduction in time is due solely to the man after he has been properly instructed as to how to best do his work. About the only mechanical assistance he has is that of the electric cranes. His physical strength and skill are responsible for fast time and good work. For this reason his percentage of bonus is higher than that for a machine man. Although he will not at first earn much, if any, more in bonus than a machine operator, he will eventually earn more, as he becomes used to looking ahead, working accurately, and making every move count. The assembler or hand worker has the advantage in this respect over the machine operator, as the latter is always more or less limited in speed by his machine and tools. Therefore, if he is unusually strong and dexterous, he can accomplish more on the floor than on many classes of machine work, provided he is inclined to "hit the pace." To sum up: an old assembling time of 125 hours, as compared to a new time of 30 hours, does not mean that a man or a group of men is working four times harder than before for

only 35 per cent increase in wages per hour. The true facts are that we can safely assume that 70 or 80 hours are saved by the firm by new and better methods at considerable expense. The man is hired and paid a day rate as a good, average, conscientious worker, for which pay we have a right to expect that under the new methods he will do the work in, say, 40 hours, and for the extra effort to meet 30 hours, we increase his pay for the whole 30 hours from 35 per cent upward, depending on the time he takes for the work. The balance of the saving belongs to the firm as additional profit and to pay for the expense of supervision, etc., on this part of the work. Bonus rates are so figured as to rapidly increase the rate of compensation per hour as time is reduced. The unusually strong or dexterous man is enabled to earn a high bonus by large production. Some bonus workers by unusual effort earn 60 per cent to 80 per cent over and above their wages. The prices are rated to be within the reach of a good average man.

I wish again to emphasize the point that a firm in the first place takes the initiative, carries the improvement through to a successful finish under more or less opposition, both from employees and outside interests, and often spends thousands of dollars before any appreciable return is realized. The firm assumes all the responsibility, the workman none at first. The details must be worked out carefully over a period of several years, and throughout this time the development must be carried on without demoralizing the business. It is for all this that the firm must be reimbursed, and it is also these things which are so prone to be overlooked by certain above-mentioned critics. The new organization in a going concern represents an investment just as much (or more) as so much plant, and will in itself yield a definite return.

When a job has once reached that stage wherein a 25 per cent to 40 per cent bonus is being earned, it can safely be left to take care of itself and attention given to other

jobs. Instruction cards similar to the one illustrated in Fig. 30 should be issued for each and every job as fast as possible. This applies to the different branches of the trades in the line of business under discussion, including assembling operations.

Careful inspection is necessary, and intensive production must not be attempted until this feature is well established. Work must be done in accordance with the detail drawings and with the quality of finish and within the limits of accuracy indicated. It is interesting to note the great improvement being realized in regard to the quality of the output under the present methods as compared to the old. The limits of accuracy indicated on all drawings, combined with rigid inspection, result in duplication of parts more nearly interchangeable, even though processed in record time, than will ever be possible otherwise.

7-C. Piece-work, Premium, Bonus, Differential Rate and Differential Bonus Systems of Paying Wages

The author believes that the employee should be generously rewarded (in addition to his hourly rate) for close application, following instructions, big output and good work. This extra remuneration should be forthcoming only when the quantity and quality of work warrant it. A man whose earning power is dependent on a scale of wages fixed by shop or local rule, is bound to follow the path of least resistance and will naturally adjust himself to his surrounding conditions. The result is a gradually decreasing standard of efficiency. Unless the workman is able to extend himself, follow the desires of his ambition, and be paid accordingly, he is doomed to a humdrum grind from which he is unable to escape. We buy material to a specified standard, also coal and other fuels; why not labor? We cannot afford, however, to pay the high efficiency price for a low output or poor quality. We must provide a means to get the results and then pay for them

when we get them, and as we get them, not before or long after, and only when we get them.

In my opinion profit sharing will never be able to solve the problem. A semi-annual or annual share in the profits of a business is too far removed and comes too infrequently to get the best results. These schemes are furthermore impracticable as they do not permit the rank and file of workers any say in the management of the business. The employee is not in a position to, nor is he trained, to take part in such responsibility. He should be able by his industry, headwork and the sweat of his brow to earn all that he is capable of earning without injury to himself or others. This does not mean that he is handicapped in the way of promotion. The contrary is true, and the opportunity is "always there" for the competent man. This extra pay should be his every pay-day, so that he can have in "cold cash" the reward due hin. The payment of this bonus on the regular pay-day has the effect of keeping before the man the fact that he has just recently accomplished something for which he is being rewarded extra. He has something tangible as an incentive to maximum production and good work. The writer makes a practice of paying bonus in a separate envelope so that it may be kept separate from the regular wage and assist toward making the man realize he has something coming to him independently of his wages.

There are now a number of men at the Ferracute works who have started savings-bank accounts with their bonus money, some of whom have saved every cent paid them as bonus. These men are profiting by this system and are being made better for it aside from the monetary factor. They feel that they have a certain direct interest in each job given them. They are stimulated to efficient work and take a pride in doing that work well.

A man's individuality must be developed and broadened, not smothered and finally lost. Harmony and cooperation must join to promote the maximum efficiency and the pros-

perity of the individual. He must be given sufficient instruction and assistance in learning to perform his work well. Do not give him a new job and leave him to his own devices. He must have confidence in his superiors and the management must always stand ready to meet a deserving and trustworthy man half-way. The management must be prepared to assume much more responsibility than ever before. The workman must be freed from doing many things previously forced upon him under the old *régime*, which details did not properly belong in the hands of a journeyman. This same statement has been made before in speaking of bosses and foremen, but it is equally true of the workers themselves.

Soldiering must be broken up and combinations among the shop men to restrict output and make industrious workmen dissatisfied or inefficient must be stopped. Until this is done, injustice must prevail. A good man must by force of circumstances, when working under such adverse conditions, come down to the average efficiency of the rest of the shop force. There is no equity in a condition like this, and while it prevails the man and employer both suffer immensely as a result. The amazing part of it is that often neither one seems to realize that it is so.

The employer must be prepared to pay generously for efficiency or he will not get best results. These results manifest themselves in various ways, chiefly maximum production, high wages (and hence satisfied employees), low costs, increased business, less permanent investment and satisfied customers. Cupidity on the part of the management is sure death to any scheme of wage payment, as it means trouble from the start. Pay well for what you get, *but be sure you get it.* Having paved the way for some form of extra remuneration by perfecting those essential preliminaries which have been the subject of these pages, the form of this extra payment must be carefully considered. In the first place, each employee must be assured of a flat rate per hour for his time. It must be realized that what

the employer purchases (and what the employee has to sell) is Time, not Output. It is the employer's right to utilize this time to the best advantage, and to this end an extra reward is offered for following instructions and realizing certain standards of efficiency. If a man is paid good wages and is allowed by his employer to waste his time (and hence the employer's money) the employer is to blame and not the man.

The piece-work system does not assure the employee a definite wage per hour. It also allows him to limit production, which he will invariably do if the piece rates are set too high, as they often are. The premium system offsets this objection by allowing the man a percentage of what he saves below a certain time limit. This time limit, however, is also often subject to the error noticeable in connection with piece-work. If mistakes are made when determining the rates, the men will either make unreasonably large wages or limit their output to what they think the firm will stand without reducing the rate. Under these circumstances, if they should produce to their maximum, the employer soon decides that the rate must be cut down, which results in trouble. Past records of work that has been done are taken as a guide by which rates are set. These records are inadequate for several reasons. In the first place, they are more or less incorrect and the conditions under which previous work was performed are so variable as to be wholly misleading. This is due to lack of standards and the perfection of the essential preliminaries so that all conditions may be known and controlled and not guessed at. The judgment of a foreman is often taken as a basis for a piece or premium rate. This man's judgment is based on past experience and is bound to be far from correct because of his lack of training in analyzing a job into its elements. The men know this and govern themselves accordingly. In the case of the job referred to above, had the time been set from past practice, taking the best record of the job, it would have

been based on 4.3 hours per piece, instead of 2.3 hours. The result can be readily foreseen. The men would either have had to earn unreasonable wages per hour or limit the output. The employer would have been tempted in the first instance to reduce the rate, or he would have to lose by limited production (with the accompanying loss of business) in the second. As soon as a rate is changed downward, trouble commences. This should never be done so long as the piece remains the same or the tools or methods on which the rate was set remains the same. If one or more of these conditions change, however, it is perfectly fair to change a standard time and make a new rate. Under such conditions, there can, and will, be no objection from the employee so long as his earnings per hour are not reduced. This rule applies to all forms of piece, premium, bonus or differential rate. After all, the success of failure of any one of these schemes of payment depends on the correct determination of the time the job should take. Too much emphasis cannot be given the fact that an accurate analysis of each job into its elements, combined with an equally accurate time study with a stop watch and written instructions to control for the future all details of the work, must be made. This accurate analysis and time study is not commonly done when setting piece or premium rates, hence the repeated failures of these systems of payment. The following diagrams are given to illustrate graphically the difference between the several well-known systems of reward mentioned above.

In all cases the horizontal or base line represents time in hours and the vertical line represents dollars and cents (based on thirty cents per hour wage). The vertical distance from the base line (at any given hour) to the hypotenuse equals the total wage. The vertical distance from the base line to the heavy black line represents (for the given time) the total amount received by the employee. The vertical distance between the diagonal (or day-wage line) and the heavy black line represents in cents the extra

remuneration received by the employee over and above his wages.

Fig. 31 represents the conditions usually found under day work, as indicated by the heavy black line. The employer gets all the gain or stands all the loss; the employee is in no way stimulated to increased effort. The result is a big variation in the times consumed on the same job for

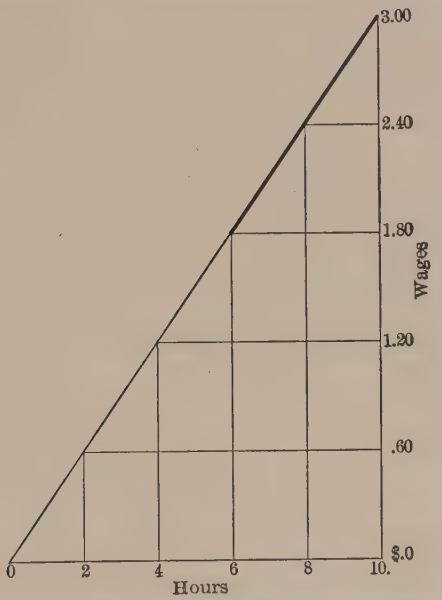


Fig. 31.—Diagram illustrating daywork method of wage payment.

each different lot. Good foremanship has its good effect, but the tendency is toward a general lapse into inefficiency.

Fig. 32 represents the piece-work line. As shown by the heavy line, the employee makes all the gain or loss. If the rate is too high, and it usually is, the result is sure to be a curtailment of output as any appreciable cut in the time means an immense increase in the total wage.

Fig. 33 shows the premium line. On this basis reduction of time nets the employee part of the saving, the employer the balance.

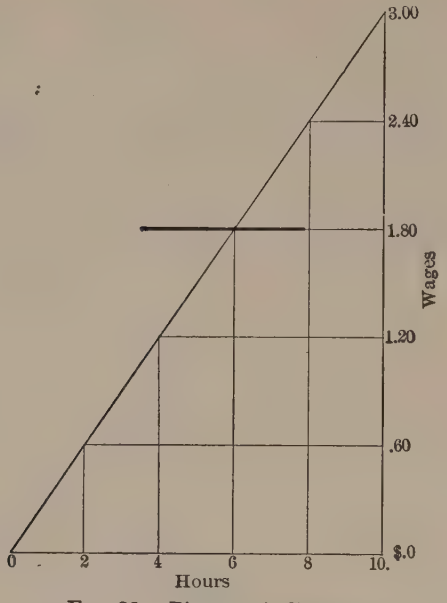


FIG. 32.—Piece-work diagram.

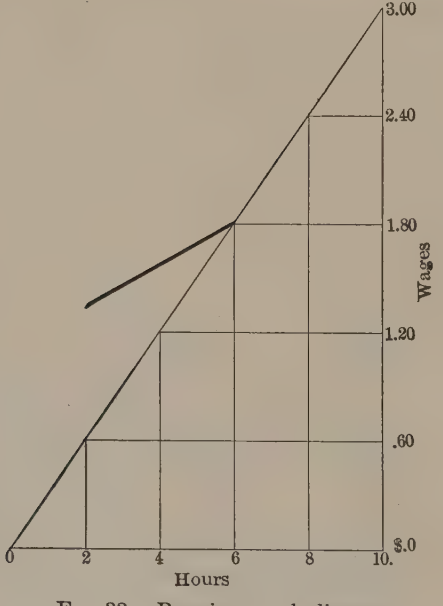


FIG. 33.—Premium work diagram.

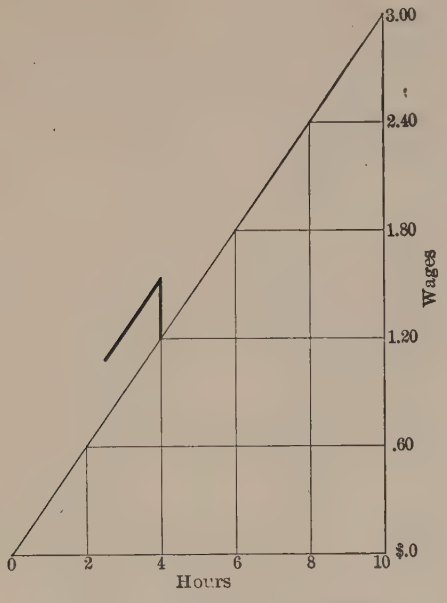


FIG. 34.—Gantt bonus diagram.

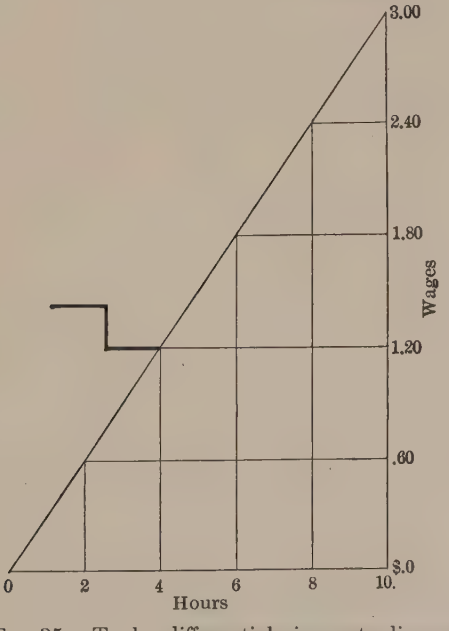


FIG. 35.—Taylor differential piece-rate diagram.

Fig. 34 shows the Gantt bonus line. Here a definite percentage is paid for an accomplished task and for following instructions. The time at which bonus commences is carefully determined by analysis and time study. When all conditions are definitely under control, this is undoubtedly an excellent method.

Fig. 35 shows the Taylor Differential Rate, based, as is the Gantt bonus, on time study and absolute control of all conditions. In both of these systems of payment a big inducement is offered to the man for increased effort and maximum production. The shorter the time the greater the reward. This is also true of piece and premium work, but there are other serious objections due to the usual methods of setting the rates, as previously explained. The Taylor differential rate is undoubtedly the best of them all when used under the ideal conditions required by Mr. Taylor. In shops of medium size, say of 150 men or less, the cost of installation of the methods and the changes required to get these ideal conditions have long been considered prohibitive by most manufacturers. There has been an idea that only the large concerns were warranted in this outlay. Bearing in mind that considerable of the expense incident to the realization of maximum production, high wage and bonus payment lies in the standardization and re-speeding of all equipment under the highest development of this type of organization, it was desirable that some means be found to compensate for a less ideal condition without this great expense. As has been previously stated, few firms are in position to make large outlays for new equipment or for changes to existing plant. To meet this variation, liable to occur in a less highly perfected organization than that advocated by Mr. Taylor, the author uses a scheme of differential bonus payment as shown by Fig. 36. The time the job should be done in is first determined by analysis and time study; the bonus is then added above the day-work line. No bonus is paid until a definitely determined time is realized. As

the time is reduced the bonus is increased. This scheme is less severe than the Gantt or Taylor method and meets the special conditions for which it was devised.

7-D. The Author's Method of Computing Differential Bonus

The same percentage of wages is not paid as a bonus for all classes of work. An operation which is performed wholly by a machine should not be rated with as high a percentage of bonus as is one requiring great manual labor, combined often with exceptional skill. Where the machine is doing nearly all the work, the operator is not taxed any more when it is running fast or under an exceptionally heavy cut (or both) than when it is doing much less work. In these cases 25 per cent to 35 per cent bonus is figured (depending on the class of work) for doing the job in the standard time. It is up to the operator to follow instructions and perform the manual operations without loss of time and to keep his machine running up to the required speed, feed and cut. Work such as fitting up and assembling requiring hard manual labor is based on 35 per cent to 50 per cent bonus, or even more.

Bonus chart 208, which has previously been referred to, is shown in Fig. 36. This is for a turning and threading (TN, TH) operation on a press shaft. This chart also shows a line representing the total manufacturing cost, using an overhead or burden charge (under the new methods and bonus) 25 per cent higher than the old burden under ordinary management. This increase in burden of 25 per cent covers all the permanent increase due to the new method, including extra maintenance cost of certain equipment subject to greater wear and tear, etc. This ratio of new to old burden is based on actual records, although the amounts shown on the chart are altered.

This chart is developed on the same basis as explained above for Figs. 31 to 35, inclusive, and the following explana-

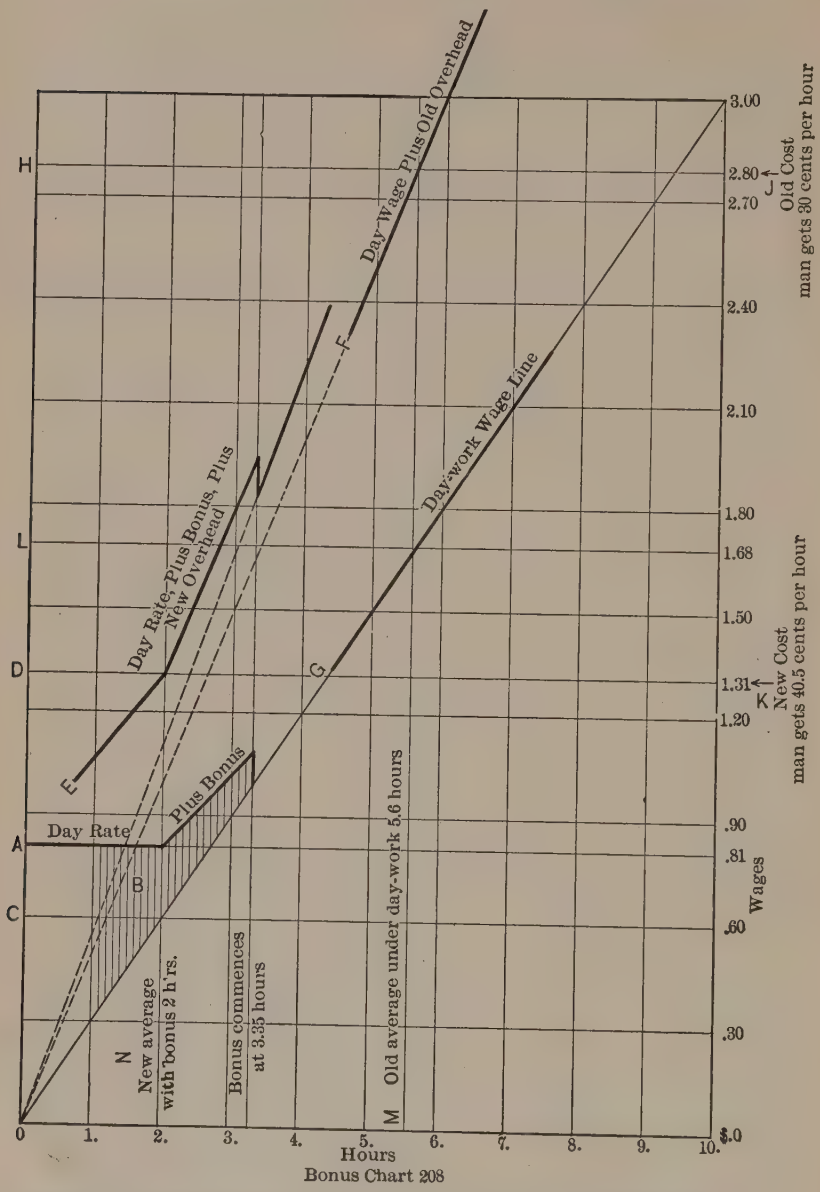


FIG. 36.—Parkhurst differential bonus. A small bonus is paid when a given time is realized. This bonus rapidly increases as the time is reduced, and the employee has every incentive to do his work quickly and well.

tion in connection with the reference letters will make it easily understood:

A. Amount paid the employee in wages and bonus; eighty-one cents for two hours' work.
B. The height of the ordinates *B* represents the amount of bonus at any given time below 3.35 hours at 0.1 hour intervals.
C. Wages at two hours.
D. Total manufacturing cost at the fast time of two hours, including wages, bonus and overhead. Note that this is $1.31 and the man's hourly pay is 40.5 cents.
E. Cost line under new methods with *high* overhead.
F. Cost line under old methods with *low* overhead.
G. Day work is but 30 cents per hour if the time per piece is more than 3.35 hours.
H. Old manufacturing cost at the old average time of 5.6 hours under day work. This is $2.80 and the employee received but 30 cents per hour.
L. Old average labor cost at 30 cents per hour for wages, amounting to $1.68 for 5.6 hours.

In making out this bonus chart, the maximum time at which bonus would be paid was fixed at 3.35 hours with a bonus of 7.6 cents. A good man will do this job in from 2 to 2.3 hours. At 2 hours the bonus is 21 cents, or about 25 per cent of the wages of a 30-cents-per-hour man. For shop use, a table of figures is made covering each specific job as explained in Chap. VI. The example given in the chapter referred to is the same job which is shown diagrammatically in Fig. 36 and here explained in detail.

The present production on this job, compared with the old average is 2.8 to 1; the new labor cost is 48 per cent of the old; the total manufacturing cost is 47 per cent of the old, notwithstanding it includes a 25 per cent greater overhead or burden, and the pay received by the man is

35 per cent greater. It should also be noted that this job is not an unusual one, picked out for example; the average of over 200 bonus jobs listed in Chap. VI showed an increase in production over day work with a ratio of 3.4 to 1.

BONUS PAID FOR LABOR AS PER CHART 16. QUANTITY 10, JOB L 3854. FINISHED SEPTEMBER 9, 1911.

Man No.	Name.	Rate.	Hours Worked.	Cent. Hours.	Bonus.
34	Lord	$.13	205.5	2671.5	$11.31
48	Oldring	.27	57.1	1541.7	6.53
51	Collins	.28	24.6	688.8	2.91
53	Baker	.17	6.5	110.5	.47
58	Murphy	.10	257.1	2571.	10.88
60	McInnis	.29	248.	7192.	30.44
64	Barry	.28	22.	616.	2.61
68	Thomas	.28	1.	28.	.12
79	Bender	.31	315.1	9768.1	41.34
82	Coombs	.27	19.2	518.4	2.19
91	Plank	.08	29.2	233.6	.99
94	Lapp	.27	3.5	94.5	.40
97	Krause	.39	5.1	198.9	.84
107	Mullins	.28	2.3	64.4	.27
111	Stanage	.17	88.6	1506.2	6.38
112	Cobb	.30	8.	240.	1.02
119	Crawford	.36	4.	144.	.61
126	Simmons	.32	135.6	4339.2	18.37
138	O'Leary	.35	173.6	6076.	25.72
140	Jones	.27	11.6	313.2	1.33
143	Willett	.31	257.4	7979.4	33.77
146	Schmidt	.31	204.	6324.	26.77
149	Bush	.33	21.4	706.2	2.99
154	Summers	.28	317.7	8895.6	37.65
162	Donovan	.09	15.4	138.6	.59
166	Gaynor	.30	33.5	1005.	4.25
	Totals	.....	2467.0	63964.8	$270.75

The author is not in favor of working men in gangs on bonus work except when it is absolutely necessary. The best results can be obtained by dividing the work up and

treating each individual's part of the job as a unit. This cannot always be done, however, especially on large and heavy work. Certain jobs that are handled as a complete unit, due to certain conditions, may also be successfully worked on the gang basis. The following record will illustrate how the bonus is divided in such cases. This job has been previously referred to in these pages.

The above is an exact copy of the original record of the work done on this job (L3854) covered by Bonus Chart 16, except that the men's names and clock numbers have been changed so as not to divulge their respective rates per hour. Each man's share of bonus is computed by multiplying his Cent-Hours (obtained by multiplying his rate per hour by the number of hours worked by him on the job) by the Bonus Constant per Cent-Hour. This Bonus Constant per Cent-Hour is obtained by dividing the total bonus for the job by the total Cent-Hours; in this case the Constant is $0.004233.

The average wage per hour on the above job was 25.9 cents; the average bonus per hour nearly eleven cents; this extra remuneration in the form of a bonus of about eleven cents per hour is over 42 per cent of the average hourly rate under day work. The average total amount paid the employee including the bonus is about 36.9 cents per hour. Four years ago the average total amount paid the workmen on this job under day work was 22.7 cents per hour for 1,100 hours per machine. The present rate per hour is therefore over 62.5 per cent more than under former day work.

Large jobs on which bonus is to be paid to a number of men require special attention daily. Aside from the extra supervision, the author has found that it is of prime importance to keep a bulletin posted in a conspicuous place in the shop showing the total hours consumed on the job to, and including, the previous day. This bulletin is changed every morning and enables the men to see just how many hours have been spent on the job. Few men

have any correct conception of time. This statement can easily be proved to the reader's satisfaction if he will attempt to estimate when one or three minutes has elapsed without looking at a timepiece. When the time is a matter of hours, it becomes more important that the value of them be fully realized.

CHAPTER VIII

8-A. A Concrete Example of the Course an Order Takes from Its Possible Existence as an Inquiry to its Shipment Complete
8-B. A Comparison of Some of the Results under Old and New Methods
8-C. Closure

8-A. A Concrete Example of the Course an Order Takes from its Possible Existence as an Inquiry to its Shipment Complete

The solicitation of orders is carried on by the sales department, the methods of which were described in some detail in one of the earlier chapters of this book. The securing of an order from a new customer should not mark the *ending* of a series of solicitation methods, but should mark the *beginning* of a new, profitable and permanent source of continued business. Satisfied customers are the best advertisement a firm can have.

An inquiry is received for a machine as per a certain specification. The sales department immediately quotes the prospective customer by letter (by telephone or telegraph, if the matter is urgent), and wherever possible arranges an interview for the engineer salesman. The first communication may not necessarily contain a complete quotation, especially if the inquiry is not absolutely specific. In such a case these points are settled personally by the representative. If the order is not secured immediately, the matter is followed up by the sales department. The correspondence file and the salesman's report file contain a complete record of the matter to date. The index to these two files is the solicitation record, by means of which every prospective customer is followed up until the order

is placed either with the Ferracute Machine Company or a competitor. This *modus operandi* is repeated as new business can be created. If purchase has been deferred the matter is indexed for attention later. When the order is finally secured by the sales department it is *viséed* by an officer of the firm, who sees that the sales department has accepted satisfactory terms and that the customer's rating or credit is such as to warrant taking the business. The order is then passed to the chief clerk (general order clerk), who proceeds to issue the three copies required. The wording of the order is made as complete and specific as possible. One copy remains on the office file, one goes to the engineering room and one to the planning department. The engineering department, by consulting the records, or by correspondence with the customer, then proceeds to issue the necessary information to the planning department. This information is in the form of a blue-print material list and blue-print sketches or detail drawings. The production clerk on the receipt of his general order immediately indexes it in a 3×5-in. card file index under the customer's name. This card states the date, order number, brief specifications of the order and the shipping date. The order is also scheduled on the machine (press) schedule. Certain regular preliminaries are followed up by this schedule, which constitutes a graphical record showing the general condition of each machine order. Orders for work other than machines are similarly handled, except through another form of schedule.

Orders for dies, repair parts, etc., are built on the order number. Parts for stock are built on stock or "L" job numbers. Machines are built on "M" job numbers and later transferred in a lump sum cost to the order number. If the work is to be done on other than the order number a job number is given to it. This job number is marked in red on the general order and all charges are made to this job number and not to the order number. The material list is then checked against the stores ledger and those

parts (if any) already finished and in stock are checked off on the material list. In such cases each item in stock is marked with the symbol IS, drawn from stores, charged to the job and put in boxes or on shelves pending their removal to the assembling floor. Those parts not yet in stock but in process on stock (L) jobs are marked with the job number, as L3061, etc. The remaining items are checked against the rough stores ledger, and the castings, forgings or other material on hand in their rough or semi-finished condition is noted.

The production clerk, or his assistant, then proceeds to issue the necessary casting purchase orders for castings required, stating the date the castings are to be delivered. One copy of the casting purchase order goes at once to the pattern foreman, who later marks on it, in the space provided, the time and date the pattern leaves his department for the foundry. Material not on hand or in process, other than iron castings, is requisitioned by the production clerk on the purchasing agent. The requisition always states the date material is wanted and where it is to be moved upon its arrival. The purchasing agent promptly issues purchase orders for all material called for, specifying the date it is wanted at the works. Its destination in the shops is shown on the receiving clerk's copy of the purchase order. All purchase orders are scheduled and followed up (through the purchasing agent) by the schedule clerk.

The next step is the analysis by the route clerk of each drawing of each piece which is to be made. The route clerk originates the schedule cost sheet which is kept up to date by the cost clerks. If the work is not standard and the drawing does not show the standard routing, the route clerk consults with the shop engineer. The route clerk issues the necessary work orders to each department having any work to do on any piece. This includes new patterns or pattern alterations. In the latter case two orders are issued to the pattern foreman; one to alter the pattern for the job in question and *one to change it back to standard*

after castings are made. Work on *both* work orders, including material, is charged to the job or order requiring the change. This method insures changes being charged to the order which originally required them, as well as *the return of all patterns to their original or standard condition.*

Each work order when issued has noted on it the bonus chart number and the instruction number, when such records are in existence. Otherwise the assistant superintendent and shop engineer see that time studies are made or the times calculated from data already in existence. Work in the shop is then controlled by the order-of-work clerk, who arranges the work orders in the planning department and shop department route racks, to enable him to have the parts to be machined ready in time for the erecting floor. This time is determined at the daily factory board meetings or by the superintendent. The time that assembling is scheduled to start is determined by making proper allowance for the assembling gang to do their work prior to the shipping date. This, and other similar work, is charted well in advance, allowing plenty of time for contingencies or unforeseen delays.

Before assembling is scheduled to start, as shown by the assembling chart, the order-of-work clerk makes a shortage list from the schedule cost sheet, if there are any parts not yet finished, to insure such delayed parts being brought through in time so as not to delay assembling. The initial movement of incoming material is controlled by the instructions on the receiving clerk's copy of the purchase and casting purchase orders referred to above. As each processing operation is completed, the work order is signed by the gang boss or foreman and passed to the move material boss. This work order has the additional function of a move order, as previously explained, and the move material boss is thus kept informed automatically and at once of all material to be moved. The inspector inspects the work done on the first piece, as well as in each successive piece of the entire lot, before the move material

boss moves it to its next destination. After the material is moved, the shop rack is adjusted and the work order mailed promptly to the planning department. The schedule boy sees that the planning department rack is cleared of the work order for the operation completed and the *next*-operation work order on this piece is moved upward into the next compartment.

All work for stock is made in batches, and for the filling of orders, wherever possible. This cannot always be done, but the method greatly expedites the work besides reducing the clerical labor incident to much repetition. Time and material charges are posted daily by the cost clerks, from the job time cards, invoices and material cards. All planning department records are kept up to date, thus assuring the absolute control of all work in process from one central department.

After the final assembling of a machine it is given a five hours' running rest and its final inspection. If the product is of new design or special, it has such additional tests as may be required by the engineering room. It is then painted and turned over to the shipping clerk. The crates (or boxes if for foreign shipment) have been made in the meantime. The orders for this work are issued at the time the other routing is done (providing crates or boxes are not in stock) being considered as part of the processing work. The shipping clerk closes up the planning department copy of the general order and forwards the necessary bills of lading or other shipping documents to the counting room. If the invoicing is dependent on the cost of the job, or any part of it, the production clerk promptly closes the cost sheets and sends a memorandum of the summary of the cost to the secretary-treasurer. The production clerk sees to the correct closing of the cost sheets as well as the filing of a summary of the cost for ready reference. When a cost is closed, all purchase orders, material cards and other charges are checked over carefully in connection with the material list and the

routing on the schedule cost sheet. This eliminates any chance of error and assures a complete and accurate cost record.

8-B. A Comparison of Some of the Results under the Old and New Methods

In Chapter VI a list (Table I) was given showing a number of *operation* times. Table II below is self-explanatory. Averages rather than extreme figures are taken. A careful inspection of Table II will show that in many cases the wage cost is not reduced in the same ratio as the hours consumed. This is due to two things. First, the new methods so control the division of labor that the man best fitted to do a job is selected for the job irrespective of his hourly rate. Some jobs previously done by a low-priced man are now done by a higher-priced help, in a much less time and more satisfactorily and at less cost. See Piece 18 in Table II. The old average wage per hour for 15.50 hours was 15.9 cents and the labor cost, including the old overhead charges, was $5.565. The new average wage per hour for 8.20 hours is 26.7 cents and the labor cost, including the new overhead charge, is $4.234. Second, all employees received a voluntary and unsolicited increase of about 11 per cent of their wages less than two years ago. Of course the bonus earned for efficiency further increases the hourly rate of all bonus workers. In other cases, work formerly done by the highest paid journeymen machinists is now done by apprentices, or men just out of their time not getting the highest journeyman's wage. An example of this will be found in reference to Piece 121, Table II. Here the old average rate was 24.4 cents per hour, giving a total cost, including the old overhead charge, for 2.50 hours of $1.11. The new time of 1.07 hours averages 9.65 cents wage per hour, or a new cost, at the new overhead charge, of $0.2675 per piece. All grades of employees should be put on the kind of work which their experience and capacity fit them for.

TABLE II

Some Labor Cost Comparisons

A record of 275 different press parts, on which individual costs have been obtained, showing the difference in processing time and wages under the old methods, as compared to the present time and wages. These records extend back only to about the middle of 1908, previous to which time individual costs were not obtainable under the old system. These times represent all the labor necessary to finish one piece.

In the case of "New Labor Costs," the wages shown always include any bonus earned by the workman, in addition to his regular wages. Less than one-half, however, of the operations necessary to process the pieces listed were on standard or bonus time. This list does not contain any assembling time costs, a few of which were given in Table I above referred to.

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
1	1.90	$.454	1.20	$.320
2	4.20	.930	.80	.217
3	3.07	.743	.75	.211
4	3.68	.905	.93	.253
5	3.70	.980	1.98	.527
6	5.35	1.375	4.16	.591
7	4.70	1.170	1.15	.307
8	4.00	.946	3.33	.845
9	2.87	.460	1.30	.328
10	3.75	.855	1.79	.400
11	3.75	.533	1.72	.475
12	4.80	.844	3.30	.770
13	6.60	1.162	4.10	.891
14	8.88	1.665	4.45	1.177
15	10.50	2.240	6.08	1.650
16	7.20	1.287	4.46	1.031
17	10.50	1.975	5.40	1.262
18	15.50	2.465	8.20	2.184
19	.25	.045	.18	.034
20	1.05	.220	.52	.118
21	.50	.099	.44	.126
22	.50	.113	.33	.066
23	.96	.189	.51	.113
24	.33	.057	.13	.040
25	.27	.066	.09	.018
26	.29	.065	.13	.034
27	.41	.097	.12	.025
28	.36	.082	.19	.047
29	.71	.193	.24	.064
30	5.54	1.241	3.31	.792
31	6.60	1.555	3.92	.816
32	7.80	1.556	3.40	.687
33	9.10	2.405	3.70	.673

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
34	1.50	.300	.68	.098
35	.97	.150	.55	.086
36	3.15	.624	1.25	.245
37	1.00	.182	.60	.084
38	4.00	.621	1.61	.293
39	1.23	.200	.81	.162
40	2.30	.517	1.52	.299
41	1.50	.196	1.00	.173
42	4.25	.813	1.84	.291
43	3.88	.520	1.18	.279
44	5.57	1.247	2.70	.480
45	3.15	.750	1.50	.211
46	2.25	.463	.65	.160
47	2.14	.550	.76	.156
48	2.00	.521	1.16	.239
49	3.30	.845	1.60	.310
50	4.15	1.065	1.42	.275
51	1.60	.193	.73	.071
52	2.22	.457	1.15	.105
53	2.50	.420	1.56	.285
54	1.57	.248	.46	.120
55	2.10	.437	.95	.245
56	.22	.027	.03	.004
57	.11	.017	.024	.001
58	2.88	.543	1.58	.273
59	3.50	.740	2.24	.394
60	4.18	.900	2.50	.585
61	2.80	.749	1.45	.348
62	4.20	1.017	1.60	.163
63	5.32	1.207	1.04	.310
64	4.80	1.180	1.00	.464
65	9.50	2.543	1.90	.457
66	2.57	.365	.89	.113
67	2.60	.360	.76	.107
68	3.14	.380	.99	.108
69	2.77	.478	.86	.156
70	1.52	.373	1.06	.127
71	4.70	.475	1.68	.184
72	.38	.468	.07	.013
73	81.50	19.440	47.10	13.778
74	75.50	18.200	35.50	9.380
75	5.36	1.210	1.78	.264
76	5.17	.914	1.76	.372

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
77	6.78	1.630	1.74	.329
78	11.85	2.830	1.86	.435
79	9.25	2.185	2.34	.331
80	4.60	1.190	2.73	.615
81	5.57	1.513	.94	.596
82	6.25	1.173	1.50	.826
83	6.12	1.516	1.90	.940
84	7.57	1.965	2.72	1.230
85	12.50	3.110	2.31	1.260
86	10.75	3.040	4.83	1.790
87	14.70	3.410	4.83	1.204
88	15.30	2.900	4.44	1.283
89	12.10	2.480	4.68	1.496
90	15.40	3.455	6.50	1.649
91	10.50	2.730	3.58	1.055
92	18.25	4.550	6.70	1.737
93	9.37	1.655	4.65	1.325
94	28.00	6.090	9.47	2.420
95	11.10	2.910	5.65	1.550
96	14.62	4.215	7.93	2.280
97	32.70	7.150	11.10	3.200
98	33.10	7.780	19.99	5.295
99	31.00	7.275	16.70	4.187
100	56.00	12.310	21.90	5.605
101	71.50	16.020	39.40	10.624
102	6.68	.893	1.77	.423
103	29.27	6.787	14.47	4.123
104	34.42	6.947	16.32	4.540
105	54.02	11.786	17.50	5.310
106	67.15	14.742	21.07	6.601
107	82.75	20.690	28.70	7.967
108	22.08	4.013	15.46	2.857
109	39.75	9.780	26.00	4.514
110	2.83	.227	1.25	.337
111	1.92	.479	.85	.255
112	1.45	.147	.84	.245
113	7.75	1.965	.72	.266
114	4.40	.470	1.08	.172
115	9.87	2.410	1.67	.421
116	4.81	.352	1.85	.551
117	1.42	.155	.92	.225
118	1.37	.150	.90	.105
119	.96	.269	.65	.079

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
120	1.23	.157	.82	.071
121	2.50	.610	1.07	.103
122	2.37	.280	1.06	.085
123	1.54	.373	1.17	.224
124	.18	.037	.06	.006
125	3.45	.603	.23	.470
126	3.75	.700	.21	.464
127	5.13	.930	2.95	.649
128	8.02	1.917	2.78	.531
129	5.60	.987	1.63	.456
130	5.47	1.309	1.63	.422
131	8.72	2.060	2.11	.504
132	10.02	2.300	1.83	.461
133	9.87	2.150	2.37	.594
134	12.13	2.830	5.47	1.074
135	.95	.185	.14	.033
136	.38	.089	.23	.055
137	.43	.073	.30	.064
138	.64	.266	.20	.045
139	1.41	.351	.45	.114
140	.05	.004	.008	.0005
141	.50	.080	.10	.013
142	.48	.090	.13	.019
143	6.41	.888	1.72	.451
144	5.12	1.160	1.27	1.940
145	5.50	1.221	1.26	.326
146	8.50	1.830	2.06	.446
147	9.12	2.270	2.60	.348
148	2.37	.325	.83	.135
149	1.62	.180	1.11	.297
150	2.15	.560	1.70	.428
151	23.44	5.975	5.77	1.691
152	20.62	4.765	7.40	1.585
153	16.75	4.410	8.30	1.951
154	16.62	3.795	9.80	2.133
155	8.44	1.916	2.93	.562
156	5.30	.918	3.13	.688
157	9.87	2.585	3.91	.886
158	7.84	1.922	2.19	.361
159	8.02	1.839	2.13	.434
160	10.60	2.135	1.70	.435
161	11.33	2.831	3.34	.690
162	13.81	3.352	5.24	1.046

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
163	14.16	2.426	9.75	1.976
164	30.20	7.374	9.87	2.453
165	34.10	6.193	11.35	2.747
166	23.10	5.294	10.16	2.245
167	33.25	6.855	20.40	5.272
168	46.75	6.610	16.30	4.815
169	3.53	.648	1.26	.258
170	16.75	3.440	6.75	1.394
171	27.12	5.940	6.00	1.443
172	33.82	7.299	6.52	2.070
173	36.05	8.728	7.87	1.860
174	37.13	7.625	14.13	2.895
175	29.87	6.155	16.05	3.315
176	10.32	2.548	3.88	1.235
177	.175	.037	.033	.004
178	.825	.127	.185	.044
179	.69	.125	.30	.065
180	1.02	.172	.29	.063
181	1.02	.140	.35	.078
182	1.54	.271	.29	.083
183	.72	.124	.58	.116
184	11.05	2.890	6.34	2.400
185	12.25	3.101	6.49	2.768
186	14.57	3.952	7.28	2.927
187	28.00	6.850	12.72	4.605
188	16.62	3.880	6.44	2.484
189	17.22	4.227	6.71	2.599
190	32.87	8.380	8.43	3.162
191	23.95	6.195	10.57	3.886
192	37.75	9.585	17.48	4.768
193	35.65	8.515	27.50	8.425
194	3.73	.938	1.45	.354
195	2.75	.680	1.01	.217
196	3.86	.947	1.90	.462
197	5.65	1.357	1.44	.332
198	9.05	1.998	1.98	.515
199	7.35	1.366	3.25	.572
200	6.15	1.523	3.60	.768
201	.70	.150	.52	.120
202	.60	.168	.29	.020
203	.54	.119	.13	.013
204	.92	.236	.24	.026
205	.66	.183	.31	.081

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
206	1.04	.203	.44	.033
207	8.80	2.070	5.25	1.430
208	3.25	.600	1.80	.249
209	2.29	.275	.78	.104
210	1.62	.165	1.12	.044
211	2.16	.298	1.74	.240
212	1.62	.293	1.00	.160
213	2.16	.266	1.36	.144
214	1.33	.213	1.00	.180
215	8.80	2.070	5.25	1.064
216	6.15	.813	3.82	1.032
217	6.85	1.512	4.08	1.190
218	9.65	1.482	5.70	1.429
219	4.60	.609	1.07	.257
220	3.90	.737	1.12	.347
221	7.60	1.507	1.64	.573
222	9.30	2.324	1.64	.554
223	11.25	2.660	2.27	.755
224	7.62	1.635	2.75	.571
225	15.91	3.840	10.56	2.243
226	3.15	.772	1.88	.383
227	6.00	1.359	1.92	.430
228	5.81	1.340	2.52	.553
229	7.75	1.652	2.98	.613
230	.64	.141	.56	.112
231	1.02	.225	.46	.120
232	2.07	.528	.51	.136
233	4.00	.666	1.03	.181
234	4.75	.660	1.19	.250
235	5.16	.792	1.42	.217
236	3.61	.895	1.54	.279
237	.13	.021	.10	.019
238	13.25	2.865	7.17	2.161
239	22.00	5.560	4.49	1.510
240	12.85	2.963	8.60	2.307
241	.39	.091	.35	.093
242	.55	.152	.39	.101
243	.50	.135	.22	.057
244	.57	.149	.37	.089
245	2.95	.429	1.10	1.963
246	3.25	.800	1.17	.229
247	3.69	.638	1.21	.288
248	3.42	.577	1.25	.312

TABLE II—*Continued*

Piece No.	Old Labor Cost.		New Labor Cost.	
	Hours.	Wages.	Hours.	Wages.
249	4.96	.886	1.92	.403
250	6.25	1.162	2.45	.614
251	6.18	1.530	2.44	.562
252	1.30	.174	.40	.047
253	2.00	.250	1.56	.186
254	2.21	.314	.56	.077
255	1.97	.292	.62	.102
256	1.40	.298	.61	.058
257	2.12	.515	1.36	.237
258	.09	.009	.015	.0025
259	12.29	2.814	4.07	1.047
260	.53	.123	.30	.056
261	1423.00	323.020	332.20	112.113
262	335.00	91.850	242.20	63.750
263	3.35	.783	1.42	.287
264	5.00	1.115	3.21	.853
265	2.77	.428	.63	.056
266	2.25	.385	.85	.225
267	4.93	.347	1.54	.169
268	5.12	1.060	3.60	.669
269	2.75	.388	1.59	.170
270	43.25	9.485	19.70	4.015
271	1.45	.154	.86	.197
272	2.05	.390	.72	.170
273	3.85	.791	1.79	.372
274	1.32	.303	.55	.125
275	.47	.108	.15	.039
Totals...	4280.00 hrs.	$973.806	1625.065 hrs.	$452.4265

The new average time consumption averages but 38 per cent of the old and the new average wage cost, including what bonus was paid, is but 46.5 per cent of the old. The total *new cost* of the pieces listed above, exclusive of material, and based on an overhead charge (or burden) 25 per cent greater than was used when figuring the old cost, is but 47 per cent of that old cost.

A more general comparison of conditions under the new methods is shown graphically by the chart shown in Fig. 37. The reference letters at the right are explained in the caption below the figure. The straight lines are drawn

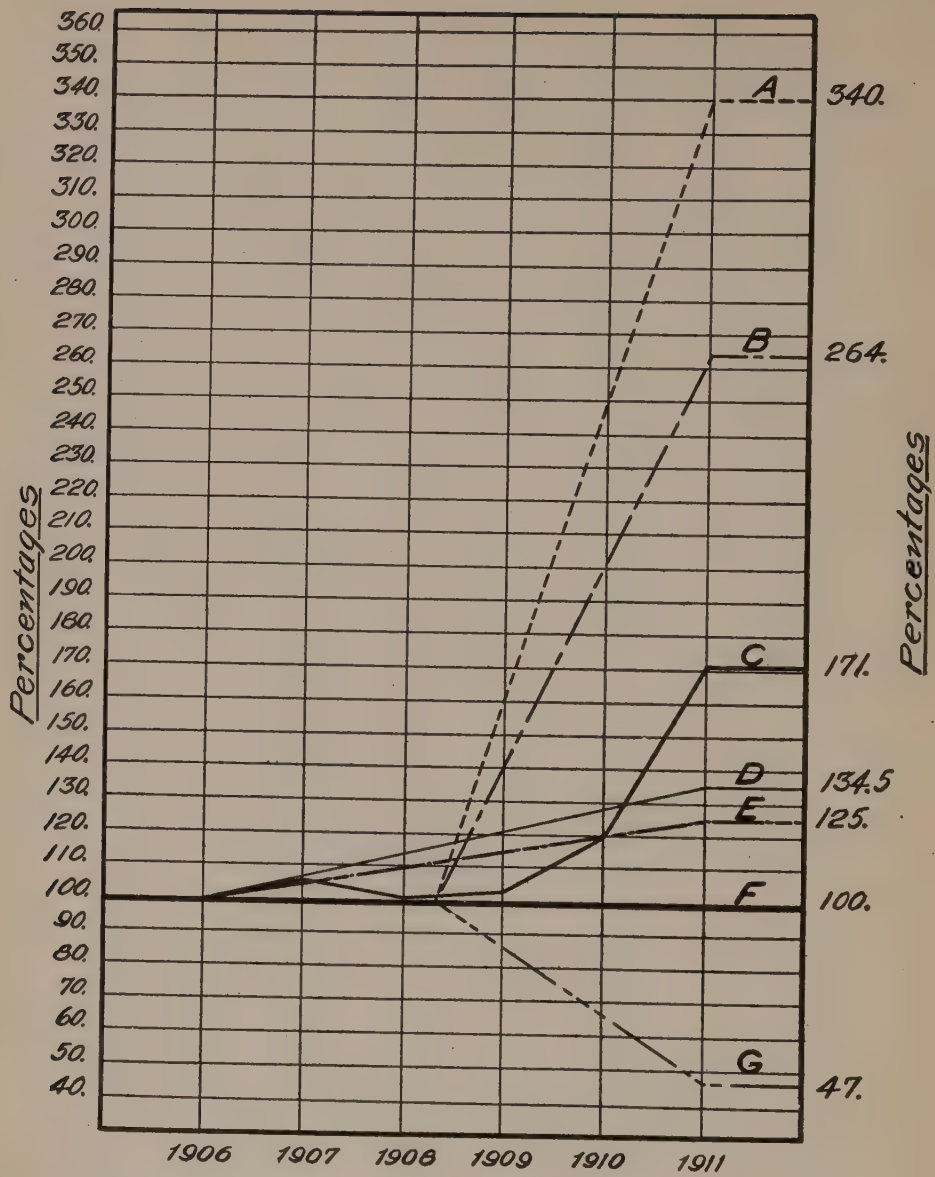


FIG. 37.—Production, wage, expense and cost chart, on percentage basis.

A. Average production on all bonus operations (1911) as compared to day work production early in 1909.

B. Average production on parts finished complete ready to AS, and on which part of the work was done under day work; the balance (less than 50 per cent) was done on standard time and differential bonus. Same period as *A*.

C. Production curve for the entire plant output per productive hour. This includes productive labor in drawing and pattern rooms, as well as all the manufacturing departments, for years 1906 to 1911, inclusive. Not corrected to compensate for difference in costs, prices, etc.

D. Average wage paid workman throughout the entire works per productive hour, 1906 to 1911, inclusive.

E. Showing permanent difference in operation and maintenance expense due to the increased cost of modern management from early in 1907, when improvements started, to 1911, inclusive.

F. Basis of comparison, starting with 1906, a most prosperous year. The class of work then was almost identical with that of 1911, although, due to adverse business conditions, the plant was not working to full capacity as was the case in 1906 and most of 1907.

G. Cost, exclusive of material, of parts represented by line *B*.

NOTE. During the first ten months of 1911 the time taken to fill all press orders has averaged less than 10 per cent more than the time asked when order was received, including Sundays and holidays.

to represent the relation between the figures of early 1909 and the latter part of 1911. Attention is called to curve *C*, which is somewhat misleading without explanation. This curve would represent a higher amount were corrections made to compensate for the difference in values of the present production as compared to the old. Selling prices, which represented the chief basis used in computing production, are, in many cases, from 10 per cent to 20 per cent lower than was the case in 1906. The production cost on stock articles is also much less. Considering all differences and compensating for them would show the actual 1911 production for the *entire* plant to be nearer 200 per cent of that of 1906, instead of 171 per cent, as shown. An additional handicap to be considered is the fact that all of these gains have been made during an unusual period of continued business depression following the panic of late 1907 and 1908; and even now the plant is not working to anywhere near its new capacity.

8-C. Closure

In the preparation of these pages the author has endeavored to make them of practical value to the business man. Keeping this point in mind, he has refrained from trying to cover much general ground, but has taken one entire organization and described its working in some detail as an illustration throughout.

The organizing engineer has before him an educational proposition. He must often combat diplomatically the old tradition founded on years of practice. He must contend with the most difficult factor of all—human nature. He will meet many people "from Missouri," who must be shown to be convinced, and even then some will not be inclined to believe the evidence of their own eyes. The reorganization of a plant and the installation of the Science of Management is the work of several years. It cannot be hurried, and the mere waving of a wand is not sufficient

to get results. Improvements must be made slowly and each step carefully planned. Each feature must be in thorough running order and in harmony with what has already been done before a new step is taken. Obstacles must be overcome and smoothed out and not dodged, to come up again later, often with fatal results. A considerable period of time must elapse before much return will be realized from the new methods. It may take several years before the new order of things is in sufficiently complete working order to run smoothly. This is especially true in a shop which has previously been run without any systematic way of doing things. In such a case not only must modern methods be started, but nearly every one must be slowly taught *how to be systematic.* When the habit of being systematic has to be established, it is a much longer and more difficult job than where it is a case of simply changing over from a system to scientific methods.

The owners and directors must first satisfy themselves that they are in accord with the new principles of management. They should investigate it thoroughly and familiarize themselves with it sufficiently to be prepared to intelligently and firmly give it their whole support, bearing in mind always that *time* is one of the chief essentials. If at the end of the first year they can see little or no improvement, they will do well to compare conditions carefully and take a calm survey of the foundation which they will find has been laid. This will be chiefly manifested by the evidence of a harmonized organization learning to stand on its own feet. Other features will be found which are beginning to quicken and strengthen the pulse, so to speak, of the entire business. Later, many petty complaints, delays, annoyances, misunderstandings and general inefficiency will be seen to be gradually giving place to a new and dominating element of confidence and cooperation.

As old traditions are overcome and replaced by the new principles, evidences of individual worth and capacity that have been in many cases lying dormant will begin to take

form and develop. As adequate and necessary records are compiled and the means of perpetuating them are perfected, a gradual increase in production and decrease in costs will be noticed. As soon as the conditions permit, initiative and good performance of one's work on the part of the individual will be recognized in the form of extra remuneration. At this stage the improvement will be fast and every gain will be a permanent one.

It is misleading and most unfair to make comparisons too early and expect quick results. All comparisons must provide for corrections to balance the difference in the product, both as to type, size and kind, and the ratio of each to the other. Unusual business conditions must be considered, as well as the conditions of both the material and labor markets. The effect of the development of new lines must also have due consideration, especially as this will often have a marked effect on the operation and maintenance expense.

In the writer's opinion the psychological part of this problem is of prime importance, and to him is most interesting. When dealing solely with material and inanimate things, it and they can be formed and molded at will. A little precaution will ensure their remaining in exactly the condition in which they are left. The human side of the problem, however, is much different. The mental development as well as the attitude of each one with whom the organizer is brought in contact must be treated, developed and so controlled, through each person's own individual desire for the best, as to net the greatest results. To-day the problem is apparently solved; to-morrow, instead of beginning where we leave off to-night, we may have to start over again, perhaps from another viewpoint. What can be accomplished with (and for) one person to-day may not be possible with another (even in the same shop and sometimes on the same job) for months. This variable is one of the features largely responsible for the length of time often necessary to reorganize a plant.

Some manufacturers thoroughly in sympathy with modern methods are prone to refrain from their adoption for fear of antagonizing the present employees. This feelig is entirely unwarranted if proper care is taken in then selection of a competent expert adviser who is familiar with all sides of the problem, and who knows how to overcome any difficulties which may arise. The reader is again cautioned against experimenting with novices in the art of management. The author concludes with expressing the hope that those in charge of affairs who have read these pages will awaken to the signs of the times and through the Science of Management realize for their employees and themselves a new era of harmony and cooperation, combined with greater efficiency and prosperity, both individually and collectively.

APPENDIX

I

Organization Record, Ferracute Machine Company, Commencing May, 1907

1. The object of this Organization Record is to furnish a copy of each Form used in the Reorganization Work now under way, with a complete description and explanation of each. Copies of all instructions will also be published as they may be issued from time to time.

2. Each member of the Ferracute Machine Co. will have his duties and responsibilities fully planned and determined. Fully detailed instructions of such will be handed him, and at the same time a true copy will be inserted in the Organization Record Book. All persons or departments affected or interested directly in such changes will be supplied with copies of such instructions.

3. It is desired that all Employees, but particularly those in the Office, or at the Head of a Department, shall familiarize themselves with the new Organization as it develops. The Organization Record Book will be kept in a conspicuous place in the Office to afford ample opportunity for this purpose.

Note.—The following pages contain some of the more important instructions. The arrangement will also serve to show how the above record is made up, though the most of them have been condensed.

II

Duties of the Vice-President and Assistant Manager

1. As shown by the Organization Chart, the Vice-president and Assistant Manager is next in authority to the President and Manager and assumes the latter's duties when he is absent. The specific duties of the Vice-president and Assistant Manager are as follows:

2. See that all instructions, rules and regulations are strictly adhered to.

3. Pay special attention to the cleanliness (inside and out) of the entire company property wherever located, and see that it is kept in the best possible condition, particularly from a sanitary standpoint.

4. Keep in close touch with the correspondence (especially the incoming mails) in conjunction with the Secretary-treasurer, and as far as possible relieve the President and Manager of routine work in connection with the smaller and less important details of the business.

5. Keep an accurate record of all complaints about faulty material or workmanship, or orders incorrectly filled, etc., and show by a detailed monthly list the expense the Company is put to thereby. This matter should be taken up in detail at the Foremen's fortnightly meeting and each item traced to the individual responsible. The result will be that soon no one will want any subject of this kind brought up in the presence of the others if it can possibly be avoided. Every one is thus prompted to do his best to always guard against errors and faulty work.

6. Follow daily the list of uncompleted orders and see that each department does its share in bringing work through to completion as scheduled. This should be followed up through the Superintendent and each and every delay or failure to " make good " must be investigated and the necessary steps taken to correct the trouble permanently.

7. Attend the Factory Board meeting held at 8 A. M.

every day except Saturday. All matters pertaining to shop routine and current or other company business should be brought up for discussion and planning at these meetings.

8. Analyze the cost of all special or odd work as soon as it is completed and keep it tabulated by order and item number for ready reference. This also applies to all work on which we do not make at least 10 per cent profit, as well as those jobs sold at a loss. The standard and nearly standard line will practically take care of itself under the special following up it receives from the Assistant Superintendent, in connection with bonus, but this should also be closely watched as part of these instructions. The above table should always be kept up to date as a ready reference for the Secretary-Treasurer and sales department.

9. Immediately after the first of each month make a list (arranged so as to be easily compared) of items in both Business and Shop Keeping expense (which figures can be obtained from the Production Clerk) and by a close analysis of each and every item in conjunction with the Superintendent note all items that are running up. Also note all items that can be reduced (and by how much) *without impairing the efficiency of the plant.* Each item should be taken up with those whom it is directly up to reduce such expense. This is a very important matter and if properly followed up will net big savings in a year. Insist that every one curtail his expense items in accordance with arrangements made after it has once been agreed that such saving can be effected, and accept no excuses when it is not accomplished. About, or good enough, has no place in our vocabulary.

10. See that the Planning Department monthly report is forthcoming each month and that the Secretary-Treasurer issues a complete monthly statement of the business showing the profit or loss for the preceding month, as well as the amount of profit for the fiscal year to that date.

11. Make an analysis of the above statement each month in conjunction with the President and Manager

and Secretary-Treasurer so that immediate steps may be taken to stop losses if they occur, or to increase the profits or earning power of the plant. The tabulated costs referred to in Paragraphs 8 and 9 will be a valuable reference at this monthly consultation. The expense rate should be fixed at this meeting and raised or lowered to suit conditions.

12. Keep in general but close touch with all departments of both office and shops, study conditions, and get familiar with the work and personnel. Make written recommendations periodically, say twice a month, pertaining to betterments your authority as Vice-President and Assistant Manager does not permit you to make directly.

III

Superintendent's Instructions

Explanation of Shop Organization

1. The Superintendent is in absolute charge of all departments of the Works outside of the office; these departments at present consisting of (as will be seen by referring to the Organization Chart) the following:

Planning Department.
Pattern Shop.
Pattern Stores.
Carpenter Shop.
Power Plant.
Forge Shop.
Stores.
Press Shop.
Die Shop.
Tool Room.

2. The Organization Chart shows the subdivision of the various above mentioned departments, showing clearly the line of authority from the Superintendent down through the Planning Department to the various manufacturing

departments. The various department heads, foremen and gang bosses are named and the limits of authority shown.

3. The Organization Chart furthermore shows who are responsible to the various gang bosses, foremen and department heads, who in turn are responsible to the Superintendent. Also what machines, tools, etc., are in charge of the various foremen and gang bosses.

Superintendent's Duties

4. The superintendent's duties either personally or through the Assistant Superintendent, are to see:

5. That the organization as far as it affects the works is being strictly adhered to and is working smoothly.

6. That the various Department Heads all have instructions in typewritten form, are following absolutely these instructions, and are keeping their work up to date.

7. Paragraph 6 applies particularly to the Planning Department, in which *all* stores, time keeping and costs *must* be daily completed to the night previous.

8. That proper discipline is maintained by the various foremen and gang bosses and that they all work in harmony for the *Company's interests.*

9. That at least every two weeks a Foremen's meeting is held (*with Assistant Superintendent present*) to further their mutual understanding of the Company's policy as it affects them and to carefully plan *in their presence and with them* the work in process for the ensuing two weeks, so that their efforts may be directed to the same end and so obviate all misunderstandings.

10. The further object of this Foreman's meeting is to record suggestions for improvements for the general betterment of the shop conditions, methods, etc., and to cultivate a feeling of personal interest and responsibility among the various gang bosses and foremen whose intimate knowledge of many of the details in connection with their tools and

equipment especially fit them to bring these matters up for general discussion.

11. Furthermore, matters of general pride such as the volume of business being handled and reduction of cost, the practical advantage of bonus system and time studies, etc., can be brought up in these meetings and the Foremen kept posted and enlightened in regard to such matters as above. This will give them a better understanding of these subjects, so instructing and helping them in the performance of their duties, through a clear understanding of the objects to be aimed at.

12. That plant, factory and other property is maintained in an A1 state of repair and is at all times under proper protection both from fire and vandalism and as far as possible from the *elements*.

13. That the shop rules are rigidly enforced.

14. The Superintendent shall keep a list or schedule of orders. This list to show two to four weeks prior to the delivery dates of the various orders what machines, etc., are planned, and for what deliveries, to enable the various parts, etc., to be made ready for the erecting floor in time to ship on the date promised. In this connection it is best to allow several days' leeway to allow for unforeseen delays. See Press Schedule, Fig. 13, Chapter IV, and Erection Chart, Fig. 23, Chapter VI.

15. Daily references to the above mentioned list will help to plan work on the erecting floor well ahead and will also enable the Superintendent to notify the Secretary when he sees that a delivery date cannot be met.

16. The detail work in connection with following the above orders is up to the Order-of-Work Clerk.

17. In naming deliveries on other than standard (or nearly so) work, consult with the Engineering Department about time required for designing and when the larger part of the information will be forthcoming; after which the time required by the various manufacturing departments can be closely estimated and delivery date determined.

18. The Superintendent must personally see to the prompt arrival of material lists and drawings from the Engineering Department and that these pass promptly through the Planning Department. This accomplished, material and patterns ordered and to the foundry and the work routed, the organization will do the rest with very little attention from the Superintendent.

19. The Superintendent should detail some competent men to personally take charge of, and follow up each new experimental job and see it through in conjunction with the draftsman representing the designer on such job.

20. The person having charge of such experimental or new work in the shops must check and inspect all drawings, details, etc., so as to reduce to a minimum the chance of error. He should also see that the various foremen and gang bosses making such new work be kept informed of where each piece goes and how used, thus further checking for interferences.

21. The Superintendent should see that stock and standard parts are made in as large quantities as the permanency of design, quantity consumed for a given period under similar conditions of business, known demands, or financial investment (consult with Secretary) will allow, considering the economical manufacture under Bonus System.

22. That these jobs are considered as important for completion on given dates as are orders, and that no night work be done on them, reserving night work to certain special order jobs or emergencies.

23. On all standard work the foundry will make up on verbal orders the required castings and hold a reasonable time. When these are ordered on formal order, see that the foundry delivers same immediately and proceed at once to make a fresh batch of *required* quantity. This eliminates the delay of waiting for foundry to make these castings which often takes many weeks.

24. Above also applies in many cases to forgings, bronze,

gun iron, charcoal nickel iron, steel castings and special metal such as clutch levers. When the vendor will not make and hold them pending formal order, see that the required quantity of such articles are kept in rough stores.

25. The Assistant Superintendent during the absence of the Superintendent assumes all his duties as per instructions above.

26. The Superintendent may from time to time detail certain of his own duties to the Assistant Superintendent in addition to whatever special duties he may have incorporated in his instructions as Assistant Superintendent.

IV

Shop Rules, Ferracute Machine Company, Bridgeton, N. J.

Rule 1

Organization Chart. The succession of authority is shown on the Organization Chart and every employee by consulting this Chart knows under whose immediate authority he is. When requiring assistance, or information, he must apply to the Gang Boss or Foreman over him and not to fellow workmen.

Employees desiring to be off duty are to apply to their Gang Boss who, before granting same, will get permission from the Foreman of the Department to grant such request.

Rule 2

Working Hours. All Departments outside of the Main Office have a regular working week of 55 hours on a basis of 7 A.M. to 12 M. and 1 P.M. to 6 P.M. 5 days, except Saturday, on which the hours are from 7 A.M. to 12 M.

Rule 3

Signals for Starting and Quitting Work. At 6.55 A.M. and 12.55 P.M. a whistle will be blown five times as a signal that work will commence in 5 minutes. At 7 o'clock

A.M. and 1 P.M. a second whistle will be blown *twice* at which signal every employee is to be at his machine bench or job, with his overalls on and prepared to start work.

The quitting signal will be blown once at 12 M., 6 P.M., and 9.30 P.M., when working evenings. Employees are requested to remain at their work until this whistle blows and machines are not to be shut down earlier or work stopped, except on Saturdays, when the small whistle in the machine shop will be blown 3 times at 11.50 as a signal for all hands to stop regular work to clean up their machines, tools and benches preparatory to leaving at the 12 o'clock whistle.

As far as practicable, machines must be kept thoroughly cleaned through the week.

Rule 4

HOLIDAYS. Legal Holidays which will be observed by all Departments outside the office are New Year's Day, Decoration Day, Fourth of July, Labor Day, Thanksgiving and Christmas.

Rule 5

WAGES. Wages will be paid at the rate agreed upon per hour and computed from the time card as registered by the time clock in the west end of the Machine Shop.

The regular pay day is Friday (P.M.). Employees then receive all wages due them up to and including the previous Saturday.

Employees are positively forbidden registering any but their own time cards in the time clock.

Time other than regular working hours, including Legal Holidays, will be paid at the rate of 1 1–3 hours pay for each hour worked except Sundays which will be paid for on the basis of 2 hours' pay for each hour worked, unless special arrangements to the contrary exist in individual cases.

It is our policy to do Sunday work only in case of special emergency.

Employees will receive the agreed upon amount of bonus which they earn on any bonus job in addition to their wages for the hours worked on such job. Bonus figures once made will remain unchanged for any one piece or job as long as said piece or job remains of the same design, and is done according to the tools and methods by which the bonus price was computed.

Rule 6

Apprentices. Apprentices will be hired under the new Apprentice Contract and subject to these Shop Rules.

Rule 7

Conduct. Employees are required to preserve order during working hours and are expected to abstain from vulgar and profane languange. No person habitually intemperate (to a degree that will damage his work) will be employed. No gunpowder or fire arms (except by watchmen) and no spirituous drinks will be allowed upon the premises.

Rule 8

Cleanliness and Order. Scrap material and all rubbish shall be deposited only in the marked receptacles provided, and not thrown promiscuously upon benches, floors and grounds. Keep everything in places provided.

Rule 9

Locker Room. All washing is to be done in the Locker Room and Employees are required to keep their extra clothing, hats, shoes, overalls, umbrellas, dinner-baskets, and all other private property (except tools) in the lockers assigned to them, which being equipped with a convenient combination lock, should always be kept locked.

Rule 10

CONDITION OF TOOLS. All employees must report to their Foreman the faulty condition of tools, machines or other equipment with which they are working. This Foreman must immediately report the same to the Tool Foreman, and if such are not put in proper shape in the shortest reasonable time, must again report to the Superintendent.

Rule 11

SPOILED WORK. An undue amount of spoiled work or breakage and misuse of tools and other equipment, will not be tolerated.

Rule 12

DANGER LINE. A danger line is marked 5 feet east of the Railroad track in Machine Shop to the west of which nothing must be left, even temporarily, except the loading platform, and that only when being used for loading or unloading a car. This rule will be rigidly enforced in the interests of the life and limb of both Ferracute and Railroad Employees. The first offense will result in a reprimand, the second in a lay-off and the third in discharge without notice.

Rule 13

ACCIDENTS. All accidents, however slight, must be reported in writing by the Gang Foreman in charge to the Superintendent who in turn will pass such report on to the Secretary, with what comments may be necessary. Every one is warned to run no risks of getting hurt for the sake of making greater speed.

Special care must be exercised in regard to being under suspended crane loads.

Rule 14

DISCIPLINE. Employees intentionally breaking the rules of the Company, are liable to suspension or discharge. If suspended, it will be for a period left to the discretion

of the Superintendent, after which time the employee may return to work.

If an employee is discharged he will receive what pay is due him at once, if during Office Hours, but if at other than Office Hours, his pay will be available for him as soon as the Office opens, such pay counting up to the time of discharge.

Employees discharged for lack of work will be given one week's notice; the management requires them to do likewise when it is their intention to leave. Men leaving

PERMIT. FORM F. A. P 40A) FERRACUTE MACHINE CO.

VISITOR'S PERMIT

Good only when signed by an Officer of the Company, or the Superintendent (or Asst. Supt.). This permit is not transferable; good for this date only and must be presented on demand while bearer is on Company property.

Admit .....

And party of ..... *Date* ..... A.M. P.M. *1910*

Signed .....

Title .....

THIS PERMIT TO BE LEFT AT OFFICE AT END OF VISIT.

FIG. 38.—Visitor's Permit.

without a week's notice will receive back pay due them the days on which it would be regularly paid.

Men being paid off and leaving our employ must return all Ferracute tools in their possession to the Tool Room, and no man will receive his pay until all property belonging to the Company is returned in good condition, or indebtedness to the Company is liquidated.

Rule 15

VISITORS. Visitors are not allowed in the works without a written permit from the office, which must be shown to the Superintendent of Foreman, and retained by the visitor. See Fig. 38.

V

Grading of Apprentices

1. Following is the approximate order of occupations and machines which the Ferracute apprentice boys follow during the four years' term.

2. Each period consists of six months as follows:

First period. Erecting floor. Rate 6 cents per hour.

Second period. Drill presses. Rate 7 cents per hour.

Third period. Milling Machines. Rate 8 cents per hour.

Fourth period. Lathe work. Rate 9 cents per hour.

Fifth period. Boring Machines, etc. Rate 10 cents per hour.

Sixth period. Planers and Shapers. Rate 11 cents per hour.

Seventh period. Tool Room. Rate 12 cents per hour.

Eighth period. Die shop and Erecting floor. Rate 13 cents per hour.

3. After the completion of the four years' term, they are considered journeymen, and are rated at three-fourths or more of the average journeyman rate.

VI

Instructions for Die Engineers

1. All die work is to be drawn in accordance with one of the following schemes. Should any doubt exist as to which scheme should be followed, the Die Engineer or his Assistant is to consult the Production Clerk or Shop Engineer, either of whom will be glad to help toward a solution of the question. Clearances, tolerances and various other allowances are to be clearly figured or marked under all dimensions requiring them, and in accordance with standards provided for same.

2. Scheme A. Any die that is a "one man job," or in

other words a small job which one man would be likely to build complete (with little or no assistance) is to be drawn only in pencil on heavy scale paper. This drawing is to show the complete die in sufficient views, sections or partial views, or both, to clearly depict the finished object. The necessary clearances are to be figured and tolerances are to be plainly marked for all dimensions of importance. The pencil drawing (original) when completed is to be sent to the Shops through the Planning Department and in accordance with the regular routine except as specified below under Emergency Jobs.

3. SCHEME B. A die similar to the above, but which is of such design or construction that several men could be employed on it to advantage at one time, is to be drawn complete, etc., as explained under Scheme A, except it is to go to the Planning Department in the form of blueprints in duplicate. See below for Emergency Jobs.

4. SCHEME C. A die of plain design or construction, or of any considerable size, is to have an individual detail drawing properly figured, of each of its pieces, except small screws, bolts, rivets, cotters, pins, springs, etc. These latter may be grouped on one or several sheets, each piece having a piece number or symbol for identification. In making "group drawings" only those pieces which are similar, or which naturally would be made in the same Department and on similar types of machines should be on one sheet. All detail drawings under "Scheme C" are to be issued in the form of Blueprints, in addition to the original assembled drawings, to the Planning Department. See below for Emergency Jobs.

5. SCHEME D. All other die work is to be drawn in the form of a separate individual detail drawing for each and every piece, issued in the form of Blueprints to the Planning Department the same as for presses and other articles of manufacture. See Emergency Jobs.

6. A material list is to be furnished for each die so that a check can be kept in the Planning Department on all

work done and on all material ordered. A partial or complete material list must be furnished with the first installment of information to the Planning Department.

7. Emergency Jobs. When the emergency demands an immediate start, regardless of cost, temporary sketches will be accepted to get the patterns and material under way, pending the completion of the drawings to any one of the above schemes, though the other routing and shop work on the job will wait on the completion of the above mentioned drawings.

8. Emergency Job. This is understood to mean a job which is to be hurried for the earliest possible date of completion, which date has been previously decided upon, at least approximately. The term is not to be used to form an excuse for delay which may have occurred in getting the information started, thus forcing the shop to crowd the work to any unusual disadvantage. The shop should be allowed the amount of time originally decided upon as needed to complete the work. All Emergency Jobs shall be so marked on the General Order.

9. All information emanating from the Drafting Room, either in the form of drawings, sketches, material lists, memoranda or otherwise, theoretically at least passes through the Superintendent's hands but actually to the Production Clerk, who sees to the forwarding of the same through the proper channels in his Department and thence to the Shops. The above applies to routine, regular or new work intended to take the regular channel, etc., but any special emergency, experimental or other job which requires unusual attention, following up, or special urging, must be taken up direct with the Superintendent.

10. Additions or changes to drawings, sketches, material lists or other memoranda already issued to the Planning Department or Superintendent, must be made through the Planning Department or Superintendent and not direct with the Foreman, Gang Boss or workmen who may be doing the work. Such procedure would not only result in

delay and misunderstanding but would prove a hindrance rather than a help. This rule does not apply to minor changes of dimensions, etc., that do not effect or require the replacement of parts already done or which do not entail remachining or refitting a piece.

11. The Die Engineer, or his Assistant will give the Planning Department, as formerly, information regarding new patterns and will furnish sketches for use of Forge Shop to expedite the making of forgings. These sketches and details as far as possible are to be on the regular " C " sheet (one piece only on a sheet) and are to be sent to the Planning Department in the form of blueprints.

12. When conditions make it desirable that certain material, etc., be requisitioned by either the die engineer or his assistant instead of the Planning Department, such requisition must in every case be sent to the Planning Department and not direct to the purchasing agent. The Stores Clerk, however, should be consulted in such cases before making requisitions to determine whether material is in stock or on order for stock.

13. Proposals for new work and naming of deliveries is to be done in connection with the Manager or the Superintendent.

14. Frequent consultations are necessary between designers (or draftsmen) and each shop foreman, gang boss and workman from the time the work starts until it is finished. The scale drawing of the assembled work must be available at all times for shop use and it is to be used in connection with all consultations above referred to.

15. The Die Engineer or his assistant must be kept in close touch with all the work that their Department issues to the shop, including the careful inspection of it in detail as it is processed, and previous to its final fitting up and assembling.

16. The completed job must be thoroughly inspected and checked against the order and specification and approved in writing by one or both of the die engineers before ship-

ment. They must also get a complete record and photograph of each new die including all desirable data, before it is shipped.

VII

Drafting Room Instructions

1. General Remarks. By referring to the Organiztion Chart, it will be seen that the Drafting Room is a subdepartment of the Engineering Room, and is in charge of the Chief Draftsman.

2. The Drafting Room is responsible for all drawings, sketches, material lists, information and photos, the above being produced by them to conform with the general designs, etc., developed by the Engineering Room.

3. All information emanating from the Drafting Room either in the form of drawings, sketches, material lists, memorandum (or otherwise) for the shops, theoretically, passes through the Superintendent's hands, but actually to the Production Clerk, who sees to the forwarding of the same through the proper channels in his department and thence to the shops. The above applies to routine, regular or new work intended to take the regular channel, etc., but any special emergency, experimental, or other job which requires unusual attention, following up, or special urging must be taken up direct with the Superintendent.

4. Additions or changes to drawings, sketches, material lists or other memorandum already issued to the Planning Department or Superintendent, must be made through the Planning Department or Superintendent, and not direct with the Foreman, Gang Boss or workmen who may be doing the work. Such procedure would not only result in delay and misunderstanding but would prove a hindrance rather than a help (except in cases of minor changes of dimensions, etc., that do not affect or require the replacements of parts already done, or which does not entail remachining or fitting a piece).

5. Standard Scale Detail Drawings and Sketches. All scale drawings are to be made on Ferracute scale or coordinate paper, as has been the practice for years past, standard size sheets of which are as follows:

A sheet, $4\frac{1}{2}'' \times 6''$
B sheet, $6'' \times 9''$
C sheet, $9'' \times 12''$
D sheet, $12'' \times 18''$
E sheet, $18'' \times 24''$
F sheet, $24'' \times 36''$

6. All detail scale drawings are to be made on the above paper, using the size sheet suitable for the piece to enable it to be drawn to $\frac{1}{1}$ scale, $\frac{1}{4}$ scale or $\frac{1}{8}$ scale, showing an abundant number of general views to enable the workmen to clearly understand and work to same, and but one piece is to be detailed on a sheet.

7. Each scale detail is to have clearly noted on it in addition to the standard sheet title, form or heading, the symbol, quantity, material, and weight, both rough and finished.

8. All dimensions of finished surfaces are to be figured and plainly marked on the drawing, the arrow points denoting the limit of the dimension, the figures wherever possible being placed near the left-hand arrow point (note Clearance and Tolerance explained below). See Fig. 4, Chapter I.

9. Finished surfaces are marked with a mark thus /, to show the surfaces on which file finish is allowed; machined surfaces are marked thus //; highly polished and smooth surfaces are marked thus ///.

10. Many plain parts such as bolts, studs, collars, pin, washers, etc., which can be clearly and completely shown by means of a neat sketch (made either by hand or with instruments) should be detailed on sketch Form FAP8b, care being taken to draw same as large as this sheet will allow with the required number of views, and although not to scale, the proportion must be maintained. This sketch

should have filled out at the bottom as provided for, the initials of the draftsman, checker, and person who approves of same, also the name, symbol, material, quantity, rough and finished weight, sketch number and date; and if there is a scale drawing of the piece in existence, this should be referred to.

11. Sketches (Form FAP8b) should in every instance be blue printed in duplicate, one of which is forwarded to the Planning Department or Superintendent, as the case may be, the other to the Tool Room. This procedure also applies to all other blueprints. A drawing is a tool.

12. All detail scale drawings or sketches are to have noted on them as soon as the Time Studies and Tool Records are complete, a list of operations with the instruction card references (see Fig. 29, Chapter VII) for each, also the tool symbols for any special tools or jigs, which may be used for the machining of the piece.

13. Dimensions, Clearances and Tolerances. All dimensions on a drawing not marked with a tolerance are understood to be scale measurements or in other words, measurements which can be made sufficiently accurate by the ordinary workman using a steel scale for the purpose. If the dimension is one which has to be calipered, such as the size of a round piece, or the diameter of a hole, then the reading of the dimension from the calipers on a scale is sufficiently close.

14. Dimensions other than the above are to be figured with the tolerance appearing below the dimension figure, as for instance $6.995''$; or if for a dimension in which the

$$\pm.001''$$

tolerance varied, it would be expressed as $6.995''$ or again,

$$-0+.003''$$

it might be a long dimension, such as the overall length of a large shaft on which an overall variation of $\frac{1}{2}$ or $\frac{3}{4}$ of an inch might not be detrimental; in which case a dimension might appear $168''$ which would indicate to

$$-\tfrac{1}{4}''+\tfrac{1}{2}''$$

the workmen that if the shaft is faced up $\frac{1}{4}''$ short ($-\frac{1}{4}''$), or was long ($+\frac{1}{2}''$) up to $\frac{1}{2}''$ or possibly more, it will pass inspection. There is a further advantage that in tolerances such as the example last mentioned, much labor and machine work can be saved by not requiring the shaft or piece to be finished to the exact nominal dimension, as in the case of perhaps a middle or main shaft, where a slight variation in the overall length outside the gears or boxes would be immaterial and would result in saving considerable labor. The Clearance and Tolerance Table shown in Chapter II is part of the original instructions.

15. Additional Allowances for Expansion or Shrinkage. In addition to the clearances, above referred to, the following allowances are to be made.

16. Where an iron or steel shaft or sleeve runs in a brass or bronze bearing or between collars connected by brass or bronze, an additional allowance of looseness must be made for difference of shrinking due to a fall of temperatures of about 50 deg. F., say from 60 deg. normal to 10 deg. in cold weather. This amounts to about .0002″ for each 1″ in question, counting diameter or length as the case may be.

17. Where the conditions are reversed, the brass or bronze running outside of iron or steel, an allowance of looseness must be made in addition to the above table for differences of expansion due to rise in temperature of about 200 deg. F. say from 60 deg. normal to 260 deg. when parts are accidentally heated by too much friction, etc. This amounts to about .001″ for each 1″ in question, counting either diameter or length as case may be.

18. Material Lists. Material Lists on Form FAP11a (see Fig. 5, Chapter II) are to be in duplicate blueprints on all orders for presses or other machines, and for orders for dies, repairs, alterations, etc., which require any considerable number of pieces. The object of this Material List is to provide a complete list of parts called for by the order or item, giving the quantity, name, material, symbol,

drawing and sketch reference for each piece, all of which will be made clear by referring to sample form referred to.

19. Material Lists must be dated the day they are made out and not the date of the order. All additions or alterations to lists after they have been issued to the Planning Department must bear the date of the change opposite the items changed or altered.

If one or more sheets are made on one date, and then additional sheets started at a subsequent date, these latter sheets must bear the date they were made and not the date of the first sheet.

20. List all pieces on the Material Lists so that as far as possible the alphabetical and numerical order in the symbol column is maintained.

21. Material Lists for al work that must be photographed before shipment should be so marked in red on on the blueprint copies issued to the Planning Department, that all will know photo is required.

22. Delivery of Drawings to the Shops. All drawings, blueprints, sketches or other information required by the Shops or Planning Department are to be promptly delivered to them by Messenger from the Drafting Room. It is extremely important that this service be prompt as practically all requests for drawing information, etc., will be made by means of either telephone or written message, not by individual Bosses and workmen in person.

23. Checker. All drawings, sketches, material lists, or other memorandum before being issued by the Drafting Room should be checked by either the Chief Draftsman or one appointed by him for this purpose. Wherever possible all checking should be done by some person other than the one who made the work to be checked, for if an error exists it is exceedingly easy and natural if a man checks his own work, to fail to find an error, whereas another, whose mind has perhaps not followed or worked out all the details, is much more likely to discover an error if it exists.

24. In checking all work, every dimension or other item

should be marked with a faint red check mark, so as to show that the Checker has been over each dimension or item and each sheet should be initialed by him when he is through with it.

25. Approval. All drawings or material lists, etc., after being checked should have the final approval of either the Chief Draftsman or one of the Engineers to make sure that there is no error in design, proportion or other feature in connection with the work. The person approving such work should in every instance initial same in the place provided.

26. Standards. A proper loose leaf book is to be kept in the Drafting Room entitled " Drafting Room Standards " in which is to be recorded properly indexed information pertaining to standards required by the Ferracute Machine Company, so as to form a ready reference for designers and draftsmen to facilitate the work of designing and drawing.

27. It is not the purpose of these instructions to record in detail a complete list and description of each and every standard which will appear in this " Book of Standards," the idea being to impress on all that as fast as a standard for any piece is developed, it is to be recorded and the Book kept up-to-date.

28. Tools. A complete and properly indexed list of all tools is to be kept on file in the Drafting Room for ready reference so that each and every draftsman may have access to it to determine what tools the shop is supplied with. Thus as far as possible designs and drawings may conform to tools already in use, to help obviate the making or purchase of new or special tools.

29. Supplies. A majority of Drafting Room supplies are kept in stock and can be obtained on material card properly signed by the Chief Draftsman from the Stores Keeper. See Fig. 19, Chapter V.

30. It is desirable for purposes of economy to draw supplies from stock in as small a quantity as is practicable say about a week's supply at a time, which will enable the

Chief Draftsman to keep a check on supplies being consumed, and will tend to reduce the consumption. It is not the intention to create red tape by requiring a material card for a pencil, a pin or a sheet of paper, but it is the intention to keep the bulk of our stationery stores under control, and let it out on material cards to the head of the department who is responsible for the reasonable and economical use of the same.

31. Special Instructions. To any draftsman making drawings for and partly designing a new machine.

32. Take instructions from head designer, verbally and with sketches, afterwards having consulations as often as necessary.

33. Make pencil scale-drawings in scales of $\frac{1}{1}$, $\frac{1}{4}$ or $\frac{1}{8}$, showing an abundant number of general views, and many fragmentary partial views, to enlarged scale where desirable, sufficient in number to positively avoid all interferences.

34. Work out all motions, other than uniform rotation, by finding location of parts in various positions, preferably by swinging or sliding pasteboard models, etc., and making " charts " of reciprocating motions where needed.

35. Calculate strengths of all parts for compression, tension, torsion and bending stresses, except in cases where the members are of well-known proportions, as proved by experience in other machines.

36. Study for the utmost simplicity of construction both in regard to shapes and to number of pieces, making one piece, or a member consisting of a group of pieces, perform as many functions as possible, as perhaps sliding and rotating at the same time.

37. Use standard parts from other machines of our build, or as purchased outside wherever possible. If not completely standard, let them have some of their details standard, as retaining diameters of some other pieces while varying lengths, etc.

38. In the designing of any piece, study how it is to be made. If a casting, plan the kind of pattern and method

of molding to be used, carefully studying the shapes that will best cast without blow-holes and without shrinkage strains. If a forging, consider of what standard sizes of bars or sheets it can be best made without waste, or too much work. Consider carefully with what tools a piece can best be machined, giving preference to those we already have. Consult the shop engineer on this point.

39. As construction of machine progresses, watch the making and assembling of parts; instruct the men who are working upon them as to their functions and methods of assembling.

40. If the machine is somewhat experimental, leave the designing of such things as springs, weights and leverages somewhat until the last, that they may be practically tested before finally adopting.

41. Mark all drawings with the measurements of the strokes, and indicate terminal positions of moving parts, as slides, levers, etc. Mark also the strength of springs in their free, initial and terminal positions, as found by actual tests. Mark also the torques, perferably in pound-inches, that is the amount of pull needed 1″ from axis of various rotating and oscillating parts, where it is necessary to know the amount of work performed or friction overcome, etc.

42. Record on drawings net weight of each piece, both in its rough and finished condition, in pounds and decimals thereof, being careful to have them weighed before assembling. If there are a number of duplicate pieces, go by the average weight.

43. In all cases where practical for finished press-frames ascertain center of gravity by hanging from two points (and plumbing therefrom respectively, etc.) which lie in a central fore-and-aft plane, thus showing the center of gravity as it appears in side view and marking the same distinctly upon the scale drawings. Its position in front view is usually not necessary as these frames are symmetrical, or nearly so, when viewed in front; if not, obtain it.

44. In case of inclinable or inclined presses, ascertain and mark on drawings center of gravity of complete press without its legs, that we may see upon side views of drawings its location in various positions of inclination, in reference to the feet or other base upon which the press stands.

45. Give a personal final running test both for operating motions and obtaining ram pressures to each new press, reporting such test to the chief designer and affording him an opportunity to also witness its final operation.

VIII

Instructions for Drawing and Sketch Indexes

1. The triplicate cross-index consists of the card Form FAP25–26–27, see Figs. 39, 40 and 41. Following the

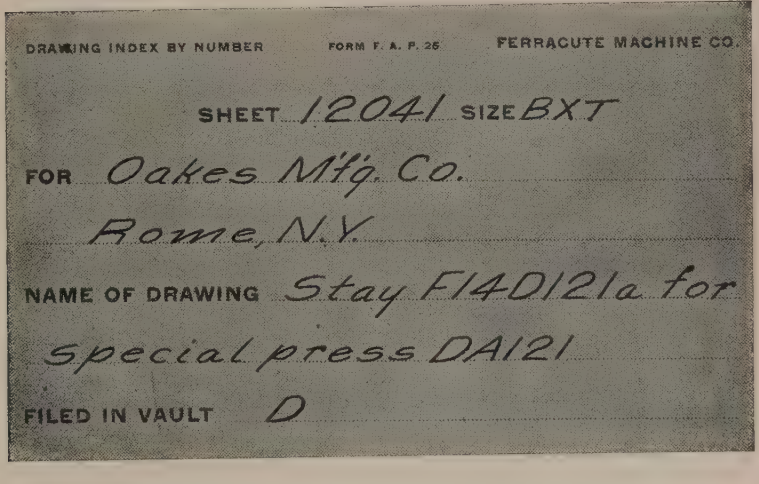
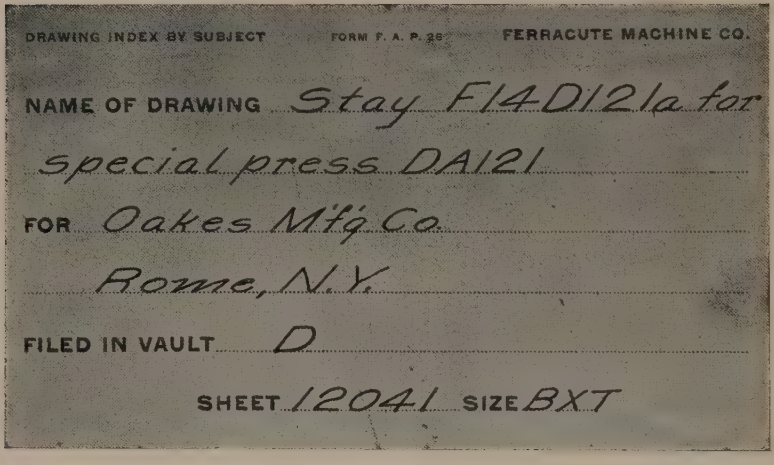

DRAWING INDEX BY NUMBER
FORM F. A. P. 25
FERRACUTE MACHINE CO.
SHEET 12041 SIZE BXT
FOR Oakes Mfg. Co.
Rome, N.Y.
NAME OF DRAWING Stay F14012 1a for
special press DA121
FILED IN VAULT D

Fig. 39.—Drawing index card filed numerically.

printed words "Name of Drawing" is to come the brief name of the piece, followed by its symbol. On the next line below is to be briefly stated for which press or machine the piece is intended. For instance, opposite "Name of

Drawing" would read "Ram RIS185" and under this would appear "Special Press S185."

2. The rest of the notations to go on these cards are


DRAWING INDEX BY SUBJECT FORM F. A. P. 26 FERRACUTE MACHINE CO.

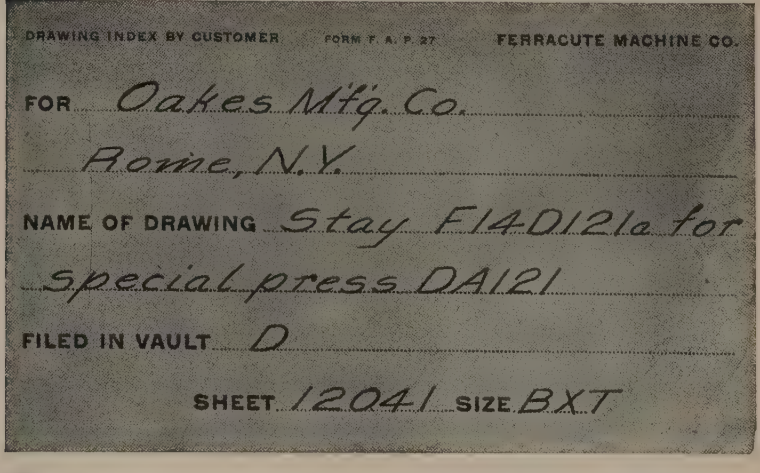
NAME OF DRAWING Stay F14D121a for special press DA121

FOR Oakes Mfg. Co. Rome, N.Y.

FILED IN VAULT D

SHEET 12041 SIZE BXT

FIG. 40.—Drawing index card filed alphabetically by subject.


DRAWING INDEX BY CUSTOMER FORM F. A. P. 27 FERRACUTE MACHINE CO.

FOR Oakes Mfg. Co. Rome, N.Y.

NAME OF DRAWING Stay F14D121a for special press DA121

FILED IN VAULT D

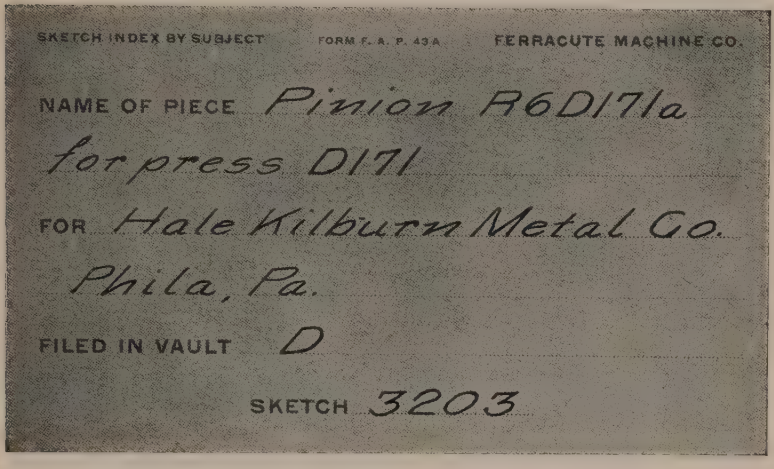
SHEET 12041 SIZE BXT

FIG. 41.—Drawing index card filed alphabetically by customer's name.

indicated by the printed wording provided. These cards are to be filed in the cabinet provided in the vault; one is arranged numerically by numbers, Fig. 39; one is arranged

alphabetically by subjects, Fig. 40; the other is filed alphabetically by customer's name, Fig. 41.

3. In filing alphabetically by customer, standard alpha-


SKETCH INDEX BY SUBJECT FORM F. A. P. 43A FERRACUTE MACHINE CO.

NAME OF PIECE Pinion R6D171a

for press D171

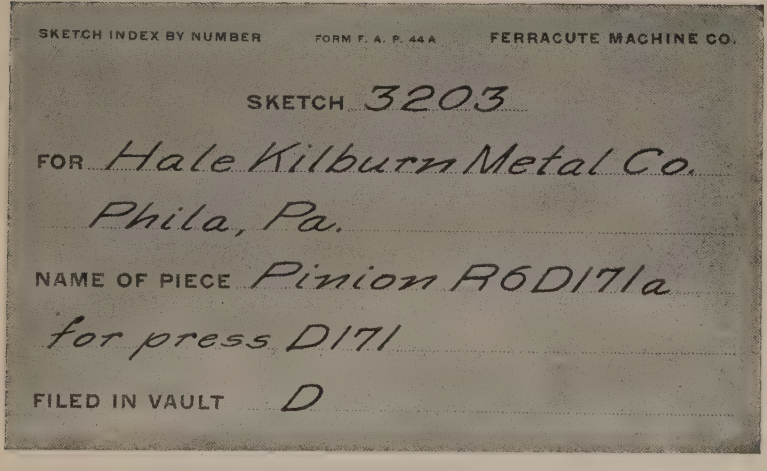
FOR Hale Kilburn Metal Co.

Phila, Pa.

FILED IN VAULT D

SKETCH 3203

FIG. 42.—Sketch index card filed alphabetically by subject.


SKETCH INDEX BY NUMBER FORM F. A. P. 44A FERRACUTE MACHINE CO.

SKETCH 3203

FOR Hale Kilburn Metal Co.

Phila, Pa.

NAME OF PIECE Pinion R6D171a

for press D171

FILED IN VAULT D

FIG. 43.—Sketch index card filed numerically.

betical index tab cards can be purchased, thoroughly subdividing the alphabet to assist in locating different names. This also applies to alphabetical index by subject, which

will be further indexed by the sub-division of the symbol to allow one to readily locate the particular card wanted.

4. Sketches will be indexed in a similar manner, except that the alphabetical index by customer will be omitted; only the alphabetical index by subject and numerical index by number being used, using the cards Form FAP43a and 44a respectively. See Figs. 42 and 43.

5. The Drawing series started years ago, and which has run on from 1 numerically, need not conflict with the sketch numbers which are also a similar series of numbers started three years ago at 1 and which is also running indefinitely. The sketches will invariably be known as " Sketch 3020 " for example and would never be called " Drawing (or Sheet) 3020." As a further check against error on the index card, it will be noted that in every instance the Drawing or Sheet number for the Drawing index is followed by a symbol of three letters, indicating its size, class and permanency (whether transient or standard) as, for instance, " Drawing 11574BXT."

6. Assuming that we eventually get to a Sketch of this same number, the Sketch would be represented as " Sketch 11574." By the above example it will be seen that there need be no occasion for confliction between these two sets of numbers.

IX

Duties of the Chief Clerk

1. The following is in accordance with the duties and responsibilities of the Chief Clerk as indicated on the Organization Chart, though in more detail.

A. Care of the Counting Room.
B. Office Hours.
C. Holidays.
D. Bookkeeping.
E. Care of Cash.
F. General Orders.
G. Pay Roll.

H. Vaults.
I. Office Records and Files.
J. Watchman's Clock.
K. Substitute to the Secretary-Treasurer in his absence.
L. Instruction of an Assistant.
M. Standardization of methods.

2. The Chief Clerk is responsible for the care, maintenance and cleanliness of the Counting Room as a department. He has charge of, and is responsible for all employees and their work in that department as described below; the regular stenographers, however, are not under his jurisdiction except as they may have to do from time to time with any of the work in charge of the Chief Clerk.

3. The office hours of the force under the Chief Clerk are from 8 A.M. to 12 M. and from 1 P.M. to 6 P.M. except Saturday, on which day the hours are 8 A.M. to 1 P.M. This totals 50 hours per week which is the nominal office week.

The Chief Clerk's hours are 8 A.M. to 12.15 P.M. and 1.25 P.M. to 6 P.M. except Saturday on which day the hours are 8 A.M. to 1 P.M. Though this total is about 49.2 hours it is assumed that the nominal total of 50 hours will be averaged. All Counting Room employees including the Chief Clerk will be paid by the hour, each receiving pay for only the exact number of hours worked.

4. Office (including Counting Room) holidays for which pay will be allowed are:

A. New Years Day—Time allowed—entire day.
B. Decoration Day—Time allowed—half day.
C. Fourth of July—Time allowed—entire day.
D. Thanksgiving Day—Time allowed—entire day.
E. Labor Day—Time allowed—half day.
F. Christmas Day—Time allowed—entire day.

Overtime will be paid for at the regular hourly rate; overtime is to be expended only when absolutely necessary and when efficient day work is not sufficient to keep work

up to date. Vacation with pay will be granted the Counting Room force for a period to be decided each year by the management.

5. A complete and necessary set of books shall be kept and maintained up to date; this includes the loose leaf or card method as well as bound books. The chief clerk must see that the detail routine is correctly carried out and that monthly trial balances are made so as to confine the work of locating errors in the accounts to not more than a monthly period. Billing or invoicing of goods shipped is to be promptly done and statements of open accounts made at least once a month. Invoices for material purchased by Ferracute Machine Company, are to be promptly checked for correction of calculations as well as against the Receiving Clerk's Copy of the Purchase Order for count, weight, etc. They are then to be promptly forwarded to the Planning Department. The Planning Department is to be promptly supplied each month with a memorandum of Business Expense for B4, B9, and B10 as per the instructions in a form of a letter to the Secretary-Treasurer, dated Sept. 3, 1908.

6. All work incident to the entire bookkeeping scheme is to be kept up to date. A complete and exact statement of the business is to be presented at least every month. This monthly statement is in accordance with the new policy of the Company and it is to be exact and complete in every way just as though the period was a yearly one.

7. At least one week prior to the end of each month the Chief Clerk will confer with the Production Clerk about the data he is to get from him. He also must get all bills, etc., through to the Planning Department, so as not to delay their work. This applies to all work at all times.

8. There must be a clear understanding between the Chief Clerk and Production Clerk as to the order in which information other than routine is required, each to the other. The routine of the Planning Department monthly statement is covered in detail in the instructions entitled " Plan-

ning Department Monthly Report" and to which the Chief Clerk is referred; the above mentioned instructions are to be considered a part of these, as an assistance to a clear understanding of what is involved in connection with a correct statement of the business.

9. Petty Cash is in the direct charge of the Chief Clerk who is alone responsible for the handling and account of it.

10. The Chief Clerk is personally responsible for General Orders in the capacity of Order Clerk as per the "Instructions Pertaining to General Orders."

11. The Chief Clerk in the capacity of paymaster is responsible for the issuance of the Time Clock Cards. At the end of each week the previous week's cards are to be promptly sent to the time keeper who will check off the total hours daily, add premium hours if any, and total the weekly hours for which each man is to be paid. This total is to agree with the daily wage distribution book weekly totals. The amount of money due each man based on the Time Clock Card record is computed and recorded on the cards at the end of each week by the Paymaster.

12. The regular payday is Friday (P.M.). Employees then receive all wages due them up to and including the previous Saturday. Time other than regular working hours, including the Legal Holidays, will be paid at the rate of $1\frac{1}{3}$ hours' pay for each hour worked, except Sundays, which will be paid for on the basis of 2 hours' pay for each hour worked, unless special arrangements to the contrary exist in individual cases.

13. In addition to the "Wages" account a "Bonus" account is to be kept so that the bonus may be at all times a separate item. It is to be shown, however, in connection with Wages or Salaries as reported for any purpose as it forms a part of the labor cost.

14. The Wage Distribution chart is to be provided with a "Bonus" column after the "Mdse." column. This bonus

to be included in the total for each week. Bonus must be expressed as a separate item.

15. The Counting Room and Basement Vaults (Vaults C and B respectively) are in the charge of the Chief Clerk who is responsible for their order and cleanliness. He is to insist on and maintain careful use of all contents of these vaults.

16. Files of all descriptions including books, catalogs, and circulars are to be kept up to date, and properly indexed. They should all be in the charge of the Filing Clerk whose first duty must be the maintenance of all these files according to the instructions for each file as they are developed from time to time.

17. The Watchman's clock is to be wound and cared for by the Chief Clerk, new dials put in daily (oftener if necessary), and the record dial *preserved for inspection.* No dial should be allowed to have but one record punched on it.

18. The Chief Clerk assumes the duties of the Secretary-Treasurer, as formerly, whenever the latter is absent.

19. The Chief Clerk must keep his substitute familiar with these instructions and all points incident to his (the chief clerk's) work, so that there will be a minimum of friction or delay whenever the substitute Chief Clerk is called upon to take up this work as he will often have to do.

20. Methods and details of the Counting Room work and equipment will be standardized by the Organizing Engineer as fast as possible and recorded in the form of instructions. The Chief Clerk must see that these instructions are lived up to and the established standard maintained.

21. Referring to Paragraph 2, the Chief Clerk must familiarize himself with the instructions and duties of each one under him, including those standards mentioned in Paragraph 20, all of which are understood to be a part of the Chief Clerk's instructions.

X

Planning Department. Production Clerk's Instructions

1. The Planning Department is the works or factory office and is the head of that part of the new organization that comes under the Superintendent.

2. All general orders go to the Planning Department direct from the sales department and all such orders are analyzed, distributed and routed through the works by and from the Planning Department.

3. As the Superintendent has sole charge of all the works outside of the offices, the Planning as stated above, comes directly under him, but is in direct charge of the Production Clerk, whose duties are outlined below.

4. Production Clerk. The Production Clerk, will be directly responsible to the Superintendent.

5. He will have direct charge of the Planning Department and will have under him the following:

A. Shop Engineer.
B. Store Clerk.
C. Cost Clerk.
D. Route Clerk.
E. Order-of-Work Clerk.
F. Shipping Clerk.
G. Receiving Clerk.
H. Time Clerk.
I. Schedule Clerk.
J. Factory Mail Boy.
K. Time Boy.
L. Inspector.
M. Stores Keeper.
N. Move Material Boss.

6. The Production Clerk's duties will consist of the following:

To see that all such part of the Organization coming under the Superintendent is working in harmony and in

strict accordance with instructions in the Organization Record Book, and if not, to report at once to the Superintendent or Organizing Engineer.

7. To see that each person under him is attending to his duties as specified in that person's set of instructions, and that each person completes his daily tasks each day, leaving nothing undone to interfere with the next day's work. Nothing must be allowed to retard the operation of the Organization or any part of it.

8. To see that General orders, material lists and sketches or detail drawings are forthcoming promptly from the Engineering Department and that the Superintendent is kept informed of everything in the Office, Engineering Department, or Works that is delaying the production.

9. To give his personal attention to the general order and press schedules and keep the Superintendent informed regarding shipping dates well in advance.

10. To act as Assistant to the Purchasing Agent in the purchase of gray iron castings and as such to see that deliveries promised on such purchases are lived up to.

11. To see that each new order as soon as it reaches the Planning Department in its *original form* (as explained under " Orders ") is promptly given a job number when necessary. This should be plainly marked upon it in red and he should see that same is entered in the order schedule showing time the number was issued, and giving an abstract of the order. If the order is a rush repair, and parts are in stock or can be taken from work in process, the Production Clerk should see that same is *immediately* gotten ready for shipment so there will be no delay on receipt of order and checked drawing reference from Engineering Department.

12. To see that the above record is made promptly and the order returned to sales department *by next mail.*

13. To see that no order is scheduled unless it bears the *visé* of an officer of the company.

14. To see that no work is started or articles shipped on an order until such general order on Form FAP31b as

called for under "Instructions Pertaining to General Orders," has been received in the Planning Department.

15. To see that all orders are executed as promptly as possible and that operations to be performed per order schedule are followed up, and if running behind schedule brought to the notice of the Superintendent. This includes completion of designing, drawings, patterns, purchases, lists, sketches, plant operations, shipping, etc.

16. To see that material lists are promptly checked for parts in stores or in process of manufacture and that parts not included in the above are promptly requisitioned and ordered for the necessary delivery as explained under "Stores Keeper."

17. To see that the Chief routing clerk is kept informed on all shipping dates and facts concerning the condition of all orders so that he may have the required time to get the work out not later than the dates called for. The Chief Routing Clerk and Order-of-Work Clerk should also be consulted regarding the Date Wanted on all requisitions before they are passed along for approval.

18. The Production Clerk is also instructed to report to the Superintendent or Organizing Engineer all facts or occurrences that directly or indirectly interfere with the operation of his department, or which may be contrary to the instructions in the organization record.

19. Instructions entitled "Planning Department Monthly Reports" are to be considered as part of these instructions.

XI

Planning Department Monthly Report

1. General Form. Each month four copies are to be typewritten to be distributed as follows, one each to:

Secretary.

One on file in Planning Department.

One for Board of Directors.

One for Organizing Engineer.

The figures are to be compiled and prepared for typewriting by the Production Clerk.

2. General Instructions. In preparing the report the Production Clerk will note carefully the details referred to below and sufficiently check the figures compiled by the various clerks in his department or elsewhere, to familiarize himself with them and satisfy himself that they are correct. The Monthly Statement made by the Accounting Room and presented by the Secretary is based upon, and its accuracy depends upon, the figures in this report.

3. Cost Clerk. The cost clerk will the first of each month see that there are no cost sheets on his files other than those for work in process. All completed, billed or shipped work must be culled out or allowance made for partial shipments or billing, otherwise work might appear both in the inventory and in bills or accounts receivable.

4. All cost sheets of expense (Shopkeeping or Business) are left in the files but a space left each month under each expense sub-division, so that each month's expense is clearly separated.

5. After carefully noting and checking the above, the Cost Clerk tabulates all orders, jobs and expenses for the month just ended. He includes under orders and jobs the prevailing expense rate per hour.

6. The Cost Clerk must be sure that he has posted to sheets all charges of time, material, sundries, etc., for the month, including invoices for all material, labor, etc., bought outside and *received* that month.

7. He must be sure that he has charged all castings (if any) received from foundry on partial shipments but for which the white copy, Form FAP19 of casting purchase order has not been received owing to entire order not being filled.

8. The receiving clerk has this record and the cost clerk must attach memo. to receiving clerk's copy Form FAP21 when he charges such partial shipment, so that when the entire order is received he will note that part of it has already been charged.

9. Valuations. The Production Clerk before having report typewritten will go over the work in process with the Secretary, to be sure that no order or job is valued or inventoried for more than that part of it done to date will net the company.

10. Stores Clerk. The Stores Clerk's routine work is kept up to date daily including posting to Stores Cards L (Stock) Jobs closed, also posting of bills or invoices.

11. At the end of each month the Stores Clerk must add all stock on hand the last day of the month after having made sure that the following items have been checked up or provided for.

12. Debits. See that all debits to stores have been posted carefully, noting:

A. That all " L " jobs completed that month are charged into stock at proper inventory value if cost is more than we get for them, otherwise at cost.

B. That all invoices for material received that month for stock are charged into stores.

13. Credits.

A. See that all credits to stores have been made for material used or drawn out of stores, which without exception must be through the medium of a material card Form FAP6a (see Fig. 19, Chapter V) properly signed by a foreman (or other authorized person) and countersigned by stores keeper.

B. In connection with the above, the Stores Clerk is to interview personally the last day of every month every foreman and gang boss to see that any material he may have to go back to stores is credited to the job it was drawn out for and charged back to stores that month.

C. The stores clerk will, the last day of each month, visit personally each store keeper and see that all material cards are turned in for material taken from stores that month. If he is holding any card for material let out, of which some is to be

returned, the Stores Clerk must see that such card either comes through at once with total weight or count, or that the unused portion of material is returned to stores.

14. Check and Adjust Stores. Stores clerk must see that at 6 P.M. the coal at Boiler Room is dressed to a symmetrical pile and measured (also the coal and coke at the forge shop) and weight calculated. The Stores Clerk then makes out a material card crediting stores with the *difference* between what the stores card shows and the amount found to be on hand at 6 P.M. the last day of the month, charging such difference to S21. The Stores Clerk then sends another material card to cost clerk crediting S21 and debiting S55 with the coal calculated to have been used while running nights.

15. Filler. Machine filler is to be checked the same way as described for coal except, of course, by actual weight and the amount found to have been used charged to S36.

16. Machine Paint. This is handled the same as explained above for filler.

17. Borings and Turnings. As the value of these is about as much as the cost of clearing them up and piling (such labor being charged to S19), S19 is credited each month with that month's accumulation at the prevailing market value, which value the Stores Clerk is to get from Secretary. The stores card record of borings and turnings is a memo. only and is not inventoried. It is a record, in other words, of the amounts handled. When a carload is sold, say in the middle of a month, the accumulation for that month must be credited in amount equal to the difference between the amount which S19 has been credited previously as an *estimated value* and what is actually received for it.

18. Scrap, Cast Iron. Cast-iron scrap of any size is weighed, the job credited, and stores debited; but the entire pile at the end of the month is to be surveyed and weight estimated, and stores card checked so that the

additional accumulation of small scrap not weighed gets charged to the stores card, and stores " over and under " credited.

19. Wrought Iron in Yard. Pile to be estimated and stores card adjusted each month, the increase to be credited to stores " over and under."

20. Adjustment of Values. The valuation of the various above mentioned scraps must be adjusted each month to conform to a fluctuating market, such value to be obtained from the Secretary.

21. Checking of Quantities. All stores cards as stock becomes low are to be checked and adjusted (or at any other time conditions require) by actual count or weight before new stock is purchased or ordered made.

22. Daily Check. The stores clerk keeps a daily record of all debits and all credits to stores during the month and makes the following check once a month, viz.: To see that all stores on hand the last day of the previous month, plus all debits to stores, minus all credits, equals the total of stores on hand the last day of the current month including the stores " Over and under " account.

23. Plant and Factory. In addition to a list of Plant and Factory jobs on which material or labor is expended each month, a plant or factory job completed that month must be so marked. The list will show its completion date and a summary of its *total cost* including material, labor, sundries and expense, so that its inventory value as a whole may be determined promptly upon its completion, while all facts in connection with such job are fresh.

24. Expense. A. Charges to Business: There are certain charges to Business in addition to those reaching the cost clerk through the regular channel, such as traveling expenses, trips, interest, expired insurance, etc., for which a memorandum will be furnished by the Secretary as early each month as possible.

B. The total " S " expense (Shopkeeping) and " B " expense (Business) divided by the total Mdse. or *Productive*

hours equals the expense rate per hour to make up the *Cost* of manufacture. (Not plant or factory jobs, however.)

C. An amount will be subtracted from the total expense each month equal to the 10 cents per hour (or other rate as may from time to time be used), distributed expense added to the *Inventoried Value* of labor done on plant or factory. Divide the balance by the Productive hours to get at the Manufacturing expense rate as explained above in Paragraph B.

25. Depreciation. Expense will also have an item of depreciation which is determined by the Secretary-Treasurer as a special item.

26. Salary Charges to Business. The Production Clerk will issue a charge memorandum each week from Chief Clerk's memorandum of salaries to charge up to Expense salaries less the President's otherwise distributed time to B3. This might in a special case apply to some other salaried men, but only in remote instances, if any.

27. Canceled Orders. Orders canceled (if any) in process of manufacture must be charged to expense S53 less whatever salvage can be inventoried.

28. No Charge Orders. Carefully look over "No Charge" orders in expense under S52 and S53 and be sure that none of these belong, or could be put, into work in process.

29. Experimental Work. Experimental work done as an expense item (either S or B) but afterwards ordered, should be charged to the order, expense credited, and the cost sheet inventoried as any other order would be. Expense can be credited the current month with material, hours and wages so as to maintain the wage distribution chart correct.

30. Change of Expense Rate. Monthly consultation with the Manager or Secretary regarding the prevailing expense rate per hour is necessary as work in process should not be charged with more expense than it is actually costing.

31. Wage Distribution Chart. Time keeper daily

adds all time cards for total hours and wages from time clock.

32. Once per week the Shop Keeping, Business, Factory and Plant time cards are added and memorandum handed to Production Clerk, who distributes these figures to wage distribution chart.

33. Mdse. or Productive Hours are determined by Difference by taking total of S, B, F, and P time and amount from pay roll as per chief clerk's memo. weekly, distributing the difference into Mdse. after it is checked to agree with the wage distribution.

34. Memo. of Salaries. Production Clerk sends a memorandum to chief clerk each week on which he records salaries, wages and hours from which time distribution is checked and salaries charged to cost sheets.

35. Monthly Sales. Production clerk will each month receive from the Secretary a memo. of the sales for the current month less royalties.

36. Partial Shipments. When inventorying work in process, be sure that any partial shipments or parts finished ahead of batches are provided for.

A. If a partial shipment, consult with the Secretary as to how much to reduce inventory shown by cost sheet for that job or order.

B. If a stock job see that the finished parts shipped are handled as explained in preceding paragraph, but if not shipped, and are in stores, see that they appear in inventory of stock.

37. Special Statistics. The June and December reports should have additional statistics, which are to be enclosed in the same cover as the regular monthly reports and include:

A. Charges to Business by months.
B. Charges to Shop keeping by months.
C. Summary of Wage Distribution chart.
D. List of Expenditures on Plant Jobs.
E. Table of Comparisons.

XII

Symbol Groups

1. Machines, etc., which are Part of the Plant. These symbols invariably consist of a numeral followed by one capital letter, as

1L, a lathe.
3P, a planer.
3W, a band saw.

2. Machines Forming Part of the Company's Product. These symbols are always one or more capital letters followed by a numeral as, for example,

C1, Cutting Press.
D3, Drawing Press.
F112, Foot Press.
DA3, Double action drawing press.

3. Operation Symbols. Operation symbols are always two letters and are as suggestive as possible, as

BO, Bore.
TN, Turn.
XP, Experiment.
FA, Face.

4. Business Expense Symbols. (B) These symbolize the different divisions which business expense is divided into for comparison, etc., as

B1, up to B10 inclusive.

5. Shopkeeping Expense. (S) The Shopkeeping expenses are subdivided as are Business expenses, the various divisions being known as

S1, up to S56 inclusive.

6. Department Symbols. Each department is represented by a symbol consisting of three capital letters as suggestive as possible, as

ENG, Engineering Room.
PLA, Planning Department.
DIE, Die Shop.

7. Order and Item. Order numbers consist of a numeral in a perpetual series followed by one or more small letters, one for each item, as 26001a.

8. Merchandise Jobs. All merchandise jobs are given a number preceded by the letter M, as M3890.

9. Stock Job Numbers. All stock or "L" jobs are given a number preceded by the letter L as, L2601.

10. Plant Jobs. All new work or additions adding to the (not maintenance or repairs) value of plant is done on "Plant" jobs which are always preceded by the letter P as, P3001.

11. Factory Jobs. All new work or additions (not maintenance or repairs) adding to the value of factory is done on "Factory" jobs, which are job numbers preceded by the letter F, as F510.

12. Drawing Numbers. Drawings are numbered from 1 up indefinitely, each number being followed by a letter indicating the size of the sheet, as 233–C.

13. Sketches. Sketches are numbered indefinitely from 1 up and are invariably known as Sketch 3001, etc.

14. Shop Numbers. The series of shop numbers running indefinitely from 1 up is the only series of plain numbers used, other symbols consisting of numerals in connection with letters or words. Shop numbers are stamped on each press or machine built and record made in the Press Record, as Shop Number 7200.

15. Manufacturing Numbers. For purpose of identification, manufacturing numbers are stamped on each piece of a batch and consist of the job or order number followed by a different capital letter for each piece in the group (or lot) made on such job or order, as L2102A, or M2601A, or 26501aA, etc., etc.

16. Piece Symbols. Each different article or piece has a piece symbol which always begins with a capital letter (one or more) followed by a number and other combinations as explained elsewhere, as WL21a, etc.

17. Special Tool and Jig Symbols. Special tools

or jigs made exclusively for use on some specific piece or pieces has a symbol which consists of the piece symbol plus the operation symbols or numbers, as SH94a13, indicating the thirteenth operation in piece SH94a.

18, Forged Planing, Turning and Boring Tools, etc., etc. These tools have symbols consisting of the letter T followed by numerals. The letter or letters indicating the kind of steel is stamped under the tool symbol.

19. Form Symbols for Stationery. All stationery forms incident to the present organization and system installed by F. A. Parklurst, M. E., are symbolized and known as Form FAP1a, etc.

20. Work Numbers. All work numbers on next work forms run from 1 to 99999 and repeat and are known always as Work Number 12400, etc.

XIII

Manufacturing Numbers

1. For purposes of identification of various pieces manufactured, especially press frames, columns, etc., such parts will be given a manufacturing number or symbol.

2. This number or symbol will consist of the Stock Job or Mdse. Job number followed by a letter, as L401A or L401G, or again M2809V, etc. The final letter of the symbol will be different on each piece built on a certain job, but the job number is the same. It is apparent by inspection that frames with the manufacturing number L401A, L401B, etc., were both built on the same stock job, viz., L401.

3. If stock job L401 calls for twelve pieces, then the manufacturing numbers run L401A to L401L inclusive. The same method, of course, applies to any manufacturing done on Mdse. Job numbers, but this will be an exception as it is desirable to manufacture only on stock jobs (which numbers are always preceded by the letter L) and are the

only job numbers used for the manufacture of one or more single pieces exactly alike.

4. The manufacturing numbers of frames will in all cases be stamped on the main casting over the finished tablet on which the ram slides. This applies also to columns. Care must be taken when filling and rubbing down not to cover the manufacturing number. It is desirable, however, that the final cost of paint, with a little machine filler, should thoroughly cover the number previous to shipping, so there will be no possibility of the customer finding and mistaking it for the shop number.

5. Other articles will eventually be numbered likewise as the necessity presents itself, and in all cases (except frames or columns which bear the shop number) the manufacturing number must be plain and in a conspicuous place.

6. In all cases the manufacturing number should be put on the article as soon as it arrives at the works, or if in stock as soon as it is drawn from stock to be charged to the job.

XIV

Anticipating Requirements, Both as to Rough Material, Machining Operations and Assembling.

1. The development of the new organization will make comparatively easy the predetermination of the approximate number of pieces to be manufactured on stock jobs or batches. These batches may have the quantity increased or decreased as time goes on, due to the variation in the demand, although undoubtedly the tendency will be for the more or less standard parts to increase in quantity rather than decrease.

2. With the stores department in good working order in connection with the proper foundry arrangements, orders can be anticipated for stock parts so that in the majority of cases, batches of standard parts are completed intact in time for requirements without the necessity of continually

breaking up operations and "Robbing" the jobs. This is an extremely important matter, because it is such a large factor in the reduction of costs.

3. Work on the erecting floor (assembling machines) should not be started until all the various parts are on the floor, ready for the erectors, so that a definite gang can be put on the machine (or a batch of machines) with everything laid out so that they can carry the work along efficiently.

4. This is especially important as soon as the erecting operations are put on a bonus, as men cannot, of course, be expected to make low times and fair bonuses unless everything is at hand to allow them to work without delays and efficiently.

5. Of course, there are exceptions to Paragraph 4, as on extremely large machines requiring a number of days to assemble. This work can be started and the gang kept efficiently busy, even though one or two parts to be erected are not on the floor. Judgment will have to be used and missing parts followed up to insure their completion in time to meet requirements of the floor hands. For example, three years ago it was a usual thing for a medium sized press to be on the erecting floor from a week to ten days to two weeks, partly because the material was not all there to allow of its prompt completion, whereas to-day this same machine, erected on a bonus, is put up in twenty-five to thirty hours for one man, or in a day for a gang of two men and a boy. Likewise, a two-hundred ton capacity press can be assembled and tested in six working days with a proper gang, whereas under the old method, three to four weeks was the usual time. These examples are simply mentioned to show the importance of strict consideration of the points previously mentioned.

6. Too much stress cannot be laid on the importance of anticipating requirements for castings, as is described in some considerable detail in the Superintendent's instructions. Every time a stock job starts through the shop, a verbal order should be given the foundry and (patterns

sent to the foundry without fail or delay) for a duplicate batch, so that in the general run of cases, this duplicate batch will be completed by the time the batch being machined reaches Stores.

7. Arrangements similar to this have been in vogue here now for four years, so that there really is no excuse for waiting on the foundry for castings. This arrangement of foundries making the castings and holding for shop delivery is one which the majority of foundries will be only too glad to take advantage of, and there are always plenty of foundries looking for business of this kind, so that there is no occasion for any uneasiness on the casting proposition.

8. The above scheme can be carried out to a certain extent with the steel foundries, and other vendors, but the chief thing to guard against is the possibility of the design being obsolete, therefore, frequent conferences between the engineers and Production Clerk are essential.

9. When starting stock jobs, a great deal of clerical work can oftentimes be saved by carefully inspecting the stores ledger card of the article in question, which record, coupled with the requirements on order, and consulation with the sales department, will enable the Production Clerk to make the quantities as large as possible. Be careful at the same time not to tie up a large amount of money, or create a stock which may last a year or more, although in many cases we can well afford to make a four or six months' supply, on account of the greatly decreased cost. On some parts a much larger supply would at times be justifiable. This is a matter, however, requiring considerable judgment. With the complete records at hand, there should be no trouble keeping and determining our best normal stock, also the most desirable quantities in which to manufacture.

XV

Follow Up Methods

Order-of-Work Clerk

The duties of the person who "follows up" or is responsible for the prompt shipment of orders are as follows:

1. See that the "Wanted" or "Completion" date is on each order when same is issued, providing a promised date has been made either at time of quotation, or is required by customer when order is placed.

2. If the Sales Department has no record or knowledge that will fix a date, then the date must be arranged with the Organizing Engineer or Superintendent, such date being based on:

A. Time required by Engineering Department to furnish required information to allow shop to proceed.

B. How much, if any, of order can be taken out of stock or is in process for stock.

C. In case of *great emergency* are there similar pieces for use for other work that can be used to make prompt shipment without delaying the work such pieces were originally intended for.

D. What time is required by the works to fill the order, considering the above mentioned points and keeping in mind the relation that the new order has to others on the books, or to deliveries previously given Sales Department in soliciting orders.

E. Always make each date as early as possible so that the orders will be rushed out and not allowed to become congested by unnecessarily long deliveries, which keep the goods from being invoiced as early as possible.

3. After the shipping date has been determined, see that same is recorded on Order schedule; also promised dates from Engineering Department or others that have a vital

bearing on the time that the works will be able to proceed, either to make patterns, order material, draw same out of stock (or from work in process), or to get started on machining and erecting.

4. Having taken care of the above mentioned points, it now becomes necessary to go over the Order schedule each day and note the following:

A. Has every order been shipped that was promised for that day? If not, investigate and keep things moving until the order is shipped.

B. Were information or material lists received as promised?

C. Is the work promised for the next few days on time? In this line, orders and details in connection with them should be anticipated a few days (or more) ahead, so that if such work is lagging it can be urged before the date promised.

D. If it is found that our orders cannot possibly be gotten out on time (that is, with all reasonable effort or expense that the particular order or circumstance may warrant) then the Sales Department should be notified in advance so that the customer may be kept advised of the condition of said order.

E. In following machines, or parts on order, but coming through on " M " or " L" jobs, the schedule of such parts or jobs should be followed and the work urged in the same way as explained above in connection with the order schedule.

F. After familiarizing oneself with the condition and progress of all the various orders and jobs, it is then comparatively easy in consultation with the Superintendent or Routing clerk to change the " order of work " as routed to the various machines and benches so as to complete such work in the order and time required to meet the delivery dates.

G. A red rush or a red, red rush next-work form should be used when *absolutely necessary* but always with the utmost discretion as they precede or side-track other work. For this reason they are not economical and this fact must never be overlooked. A rearrangement of the order of the "next-work" forms in the Planning Department route rack will in most cases give the desired preference; the boy in charge of such rack at the same time changes the shop rack.

5. It is important that the Casting Purchase Order schedules should be watched for the prompt delivery of material purchased outside (consult with schedule clerk).

6. Stock or "L" jobs on being started and scheduled will have completion date noted and it is necessary that they be followed and completed on time. Dates furnished on orders will many times be based on some such job in process, though the completion dates on "L" jobs can ordinarily be extended to favor work on order, provided of course, that some important order is not side-tracked by so doing.

7. It is important that repairs be given all the advantage possible over all other orders (except *perhaps* in some special case of a large or important contract that may involve much money or other consideration). Careful planning will in the majority of cases allow these repairs to be worked in, in connection with other order work so that although ahead of the repair, it will not be so appreciably delayed as to interfere with its date of delivery.

Orders being processed on a *Red Rush* work order must be especially followed and given preference over all other work.

XVI

Movement of Batches in Installments

1. When it is desirable to move part of a batch of pieces as fast as an operation is completed, or as fast as several pieces may be ready, so that work may be started at another machine on the next operation, the following method is employed.

2. The move material boss must make a move material order, Fig. 12, Chapter IV, stating the quantity moved, from what place and to what destination, work numbers for both orders, and show clearly thereon that it is a *partial* movement.

3. The next-work orders must both be marked each time part of the lot is moved, plainly showing on the back the number of pieces moved and the date. The work order receiving the material can be moved up into the middle compartment at the time the first installment arrives and the note on the reverse side will explain the partial quantity so that work can start at any time thereafter. This method is to be followed only when lack of time prevents the completion of the entire batch before moving for, and starting, the next operation.

XVII

Route Rack Signals

A red signal card is put in the top compartment in the Planning Department route rack for each machine not in operation. This rack is checked up every morning and every afternoon, immediately after starting time by the Order-of-Work Clerk. If there is no work for the machine to do, the condition of the rack shows it by the absence of next-work order forms in either the middle or top compartment. A red signal card in a machine compartment with work orders in the middle compartment, but none in the top compartment, indicates that the machine is without an

operator and that no work is set in it. If there is a work order in the top compartment behind the red signal card it indicates that the machine is without an operator and that the job specified on the said work order is standing idle in the machine. If the red signal card in any of the above cases displays a large letter R it indicates that the machine is undergoing repairs and cannot yet be operated. The absence of a red signal card indicates that the machine is running, providing, of course, the rack contains work orders in the top compartment.

XVIII

Stores Clerk

1. General Instructions. Stores Clerk has charge of, and is responsible for the Stores Ledger which is in card form, using Form FAP7a, see Fig. 17, Chapter V, which Stores Ledger forms a perpetual inventory of all stores on hand, either rough or finished.

2. The Stores Clerk is to see that the Stores Ledger is kept up to date, both as regards stock taken out and also material received into stores, including work finished by the shops on " L " or other jobs and chargeable to stores.

3. This card is so designed as to show the source of every bit of material charged to same, as well as the date, purchase, job, or other number, quantity received and price. This card also shows a quantity balance and cash balance. Material taken out of stores is to be recorded on the card giving the date, number to which same was charged, quantity, price and amount, leaving a reduced quantity and cash balance.

4. Pencil notations should be made on the Stores card whenever material is requisitioned or ordered for stores, showing the date, and job or purchase number, on which said material is coming, so that in referring to the stores card the amount on hand is not only visible but also the notation above referred to, showing what is due on order.

5. Material charged into stores at a price which is too high, say for example a piece manufactured by us and costing more than we would get for it, should be priced at a new amount. The new amount to appear in the price column in red under the cost price (which always appears in black) and the cash balance of the stores card reduced to equal the proper amount for the quantity on hand at the new price. Entries are all in black except price column. Stores clerk should, in adjusting prices as above explained, consult with the Secretary to be sure that the inventory value meets with his approval.

6. By keeping in close touch with the stores keepers, the stores clerk can keep his entire inventory properly checked so that it will practically equal the actual stores on hand. The most satisfactory way to do this is to have the Stores Clerk see that the various stores keepers when turning in material cards for the different stores which are getting extremely low, make a memorandum on the card at the time, showing the quantity on hand. This allows the stores keeper to check and adjust his card and requisition additional stock.

7. Whenever stores are requisitioned, the card must in every instance be checked with the quantity on hand and the stores card adjusted if necessary.

8. The Stores Clerk will also see that the section and space numbers are recorded on each stores card, and insist on the various stores keepers, when drawing stores out of stock, plainly note on the material cards the section and space from which the stock is taken. This will almost invariably make a sufficient check, aside from the wording on the material card, to insure the proper stores card being credited with the amount taken.

9. The Stores Clerk is responsible for stock being replenished whenever it gets low and is cautioned to be sure and requisition, or order made, any and all stock as soon as the stores card shows it is getting low. In this connection he must either maintain the stock as per the amounts

called for in the right-hand upper margin at minimum, maximum or danger limits, or where he does not have this information he must base his requisition or order on the quantities used for a reasonable period, or by consulting the Superintendent or Secretary, or both.

NOTE. See Superintendent's instructions regarding this subject.

10. MONTHLY REPORTS. The third or fourth of every month the Stores Clerk will be called on to give the Production Clerk a memorandum of the value of stores on hand the last day of the preceding month, as per the following example:

STOCK ON HAND DECEMBER 31, 1910

Drawer 1—Rough Stock,	"A to R"	$13653.30
" 2—Rough Stock,	"S to Z"	11021.80
" 2—Presses, Attachments, etc., ready to ship		26445.50
" 2—Friction Clutch,		3072.70
" 2—Pin Clutch,	"A to K"	4516.00
" 3—Pin Clutch,	"L to W"	15400.20
" 3—Press Parts,	"A to D"	8167.20
" 4—Press Parts,	"E to R"	35155.80
" 5—Press Parts,	"S to W"	13982.30
" 6—Bar Metal		29375.60
" 7—Sheet Metal		1673.50
" 7—Stationery		4824.40
" 7—Lumber		6889.60
" 7—Miscellaneous,	"A to E"	12589.30
" 8—All stock not under E,	"M to O"	11300.60
" 9—Other Headings		8891.00
		$206868.80

11. The Stores Clerk's routine work is to be kept up to date daily including posting to stores card all "L" (stock) jobs closed, also posting of bills or invoices.

12. Paragraphs 10 to 22 inclusive in "Planning Department Monthly Reports" are to be considered part of these instructions.

13. STORES OVER AND UNDER. An account is kept called "Stores over and under account," to which is debited all stores unaccounted for and which is credited with all stores found over.

14. Scrap Bronze, etc., from Shop. Scrap bronze, brass, copper, etc., in the form of chips or pieces are to be kept in the stores rooms in the stencil-marked barrels provided. In all cases they are to be credited to the job from which they came, by the various foremen and gang bosses at the time the job is completed. None of this valuable metal must be allowed to stay in the shop.

15. Lots. Such stock as a miscellaneous assortment of springs, various shapes and thicknesses of a certain kind of metal, etc., etc., can be recorded on stores cards and given a lot number. For instance, Lot No. 10 might represent a lot of 50 or 60 miscellaneous steel oil-tempered springs of various sizes which might be priced at so much a pound, and charged out as "coming from Lot No. 10, 3 lbs. of miscellaneous springs," so much money. This will facilitate the entering and keeping track of this class of stores.

16. Lot numbers can also be used to advantage in case of short miscellaneous lengths of cold-rolled steel, or miscellaneous scrap machine steel, etc., etc.

XIX

Instructions for the Care and Inventory of Scrap Metals

1. Borings and Turnings (Iron and Steel). Quoting from the Stores Clerk's instructions, the following is the method used in handling borings and turnings.

2. As the value of these is about a much as the value of clearing up and piling (such labor being charged to S19), S19 is to be credited each month with that month's accumulation at the prevailing market value, which value the Stores' Clerk is to get from the Secretary.

3. The Stores Card record of borings and turnings is a memorandum record only and is not to be inventoried. In other words, it is a record of accumulations from month to month and the prevailing values. When the Shop is cleaned up at the end of the month, special care must be exercised to see that the accumulation on hand at that time

is put in the pile at the west end of the Machine Shop in the open space provided for this purpose. The pile should then be surveyed so as to make the above-mentioned record as accurate as possible.

4. When a carload is sold—say in the middle of the month, the accumulation for that month must be credited to S19. The price, however, is to be one that will even up any difference between the amount that S19 has been credited with previously (at an estimated value for that period) and what is actually received for it at the time that it is sold.

5. Cast-iron Scrap. Any cast-iron scrap of any size is to be weighed and the job from which it comes credited; the Stores Account is of course, to be debited but in addition the entire pile of cast-iron scrap is to be surveyed and the weight estimated at least once a month. If the amount on hand happens to be small the entire lot should be weighed. In any event, the Stores Card must be checked at least once a month so that the total scrap on hand practically agrees with that shown on the card. The amount of any required adjustment must, of course, be carried into the "Stores Over and Under Account."

6. Wrought Iron in the Yard. The pile is to be estimated or weighed and the Stores Card adjusted every month and the required notation made on the "Stores Over and Under Account."

7. Miscellaneous Scrap not Otherwise Provided for. All miscellaneous scrap not otherwise provided for is to be handled as above mentioned for iron and the accounts kept separately for each different kind of metal, and the Stores Cards are to be adjusted and revalued at least once a month.

8. Bronze and Similar Metals. There are large steel cans provided in the Stores Room in which are to be kept the following scrap-metal, whether in the form of old or condemned parts, or chips or borings. These barrels are marked respectively:

A. " Bronze Chips."
B. " Manganese Bronze Chips."
C. " Cramp's No. 1 Gear Metal Chips."
D. " Williams' Bronze Chips."
E. " Williams' G. T. Bronze Chips."
F. " Bronze Scrap."
G. " Brass Scrap."
H. " Copper Scrap."
I. " Iron and Steel Scrap."

9. All incoming scrap-metal coming under any of the above mentioned headings must be accompanied by a Material Card properly crediting it to the job from which it comes and charging it to Stores. The barrel into which this incoming scrap or chips is to be put must be clearly marked on the Material Card. The Storekeeper's attention is called to the fact that he must accept no scrap-metal except on a Material Card made out as described and issued by either the Production Clerk or Route Clerk in the Planning Department. If any of these metals are to be turned into Stores by Gang Bosses or Foremen and they have not been provided with the proper Material Card from the Planning Department they must get one before turning the metal into Stores.

10. All Foremen and Gang Bosses must pay especial attention to the care of any of these bronze or brass metals, whether in the form of castings, chips or turnings. This metal is exceedingly valuable and while pieces are being machined care must be taken to see that the chips do not fly all over the place. They must be caught in a pan and the machine so shielded as to prevent their being lost or mixed with other dirt. All of such scrap must be turned into Stores promptly after the job is finished, or if it be a long job such scrap must be turned into Stores every night before quitting time.

11. The Planning Department in routing work to be done in any of these bronze or similar metals must attach a Material Card to each Work Order, properly made out

and signed in accordance with the above instructions. The Storekeeper on receipt of such card and incoming metal will fill in the weight and *visé* the card.

12. The headings on the Stores Cards must agree exactly with the headings mentioned above in these instructions (Paragraph 8) and the same terms must be used in making out these Material Cards so there will be no mistake in getting scrap metal into the wrong barrel. All of these metals have their own particular scrap value if kept clean and separate, and the value is greatly lessened by mixing them or allowing them to become mixed with dirt or other kinds of chips.

13. General Remarks. Every piece of scrap-metal (no matter from what source) should be reported to the Planning Department promptly by means of a Material Card in every instance. When the Material Card is not at hand and accompanying the Work Order, it is up to the Gang Boss or Foreman to inquire and see that the Material Card is forthcoming.

XX

Chief Cost Clerk's Instructions

1. General Instructions. The Chief Cost Clerk is responsible for the condition, care, and accuracy of all cost sheets for both live and completed work. He is furnished one assistant.

2. All cost sheets must be kept up to date. All labor, and other charges to same, at the close of work each night, must be posted to sheets up to and including, the charges for the day previous.

3. If the Cost Clerk's work is being interfered with or delayed by hindrances beyond his control, he must immediately report same to the Production Clerk.

4. All cost sheet files must be kept clean and neat, and only live work in process must remain on the said files. Work shipped or completed, or jobs otherwise closed, must

be removed from the files as soon as the Chief Cost Clerk is satisfied that all charges that belong to them are posted.

5. Details. Refer to Plates VII and VIII. The Cost Clerk will receive notice from the Production Clerk on either the department order (see Fig. 47 Appendix), general order form (see Plate IV, Appendix), or memorandum, for every new order, job or expense issue. The Chief Cost Clerk must personally see each day that the cost sheet is opened for such new work and the proper headings filled in. When the schedule cost sheets are used this heading is filled in by the Route Clerk, for all work in process except stock jobs. The Production Clerk issues the schedule cost sheets for all work for stock. The sheet filled in and O.K'd. by him is the Route Clerk's authority to proceed with the work called for. Headings should be complete, stating the customer's name, date of order, job, order, and item number, and the customer's number, as well as a complete specification indicating what is to be furnished. This specification may be brief, but at the same time must be sufficiently complete to form a clear record for reference purposes.

6. All regular time, material charges and sundries are to be posted to the cost sheets in black ink.

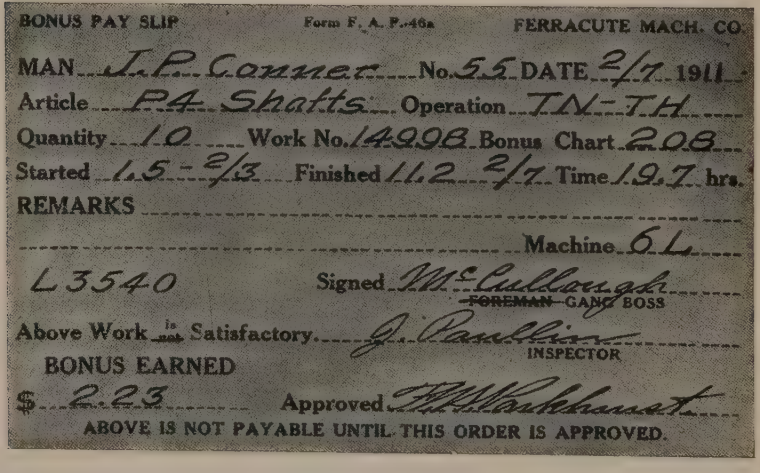
7. All over time, including the premium, must be posted to the cost sheets in green ink. Note that all premium paid on over time is to be marked in the left-hand description column, as for example "One hour's premium." The hours for premium itself not appearing in the labor division column—only the amount of money.

8. All credits to the cost sheet are to be made in red ink.

9. All bonus charges to cost sheets are to be posted in black ink in the proper operation column. The Cost Clerk is to post no bonus unless the record of it comes to him in the form of a bonus pay slip properly approved (See Fig. 44). Reading from left to right is to come the date, bonus chart number, man number, man rate, and then the amount of money in the column having the proper

operation and work number heading. These bonus pay slips will be checked by the Production Clerk before going to the Cost Clerk. The Production Clerk will note on each the job number to which the bonus is to be charged. The Cost Clerk must carefully check this job number and the work number with the numbers on the cost sheet to which he is posting the bonus charge.

10. All inventory figures, whether monthly or for any other period, must always be made in yellow ink.


BONUS PAY SLIP Form F. A. P.-46a FERRACUTE MACH. CO.

MAN J. P. Conner No. 55 DATE 2/7 1911

Article P4 Shafts Operation TN-TH

Quantity 10 Work No. 1499B Bonus Chart 208

Started 1.5 - 2/3 Finished 11.2 2/7 Time 19.7 hrs.

REMARKS

Machine 6 L

L 3540 Signed W. E. Cullough
FOREMAN GANG BOSS

Above Work is Satisfactory. J. Paullin
INSPECTOR

BONUS EARNED

$ 2.23 Approved H. W. Clarkhurst

ABOVE IS NOT PAYABLE UNTIL THIS ORDER IS APPROVED.

FIG. 44.—Bonus pay slip. No bonus is paid unless it is authorized by one of these orders duly approved.

11. All material charged must show the weight, in addition to the number of units whenever this information is available.

12. All charges to cost sheets for materials or sundries from invoices must state the name of the person or firm from whom the invoice comes, as well as the purchase order number. The material column must contain a statement of what the piece is with its weight and amount. Where freight is to be included in the bill, same must appear as a separate item on the next line, but is to be posted in the sundries column.

13. As soon as the sheet is filled at the bottom, each vertical column must be added and the total carried across the bottom of the sheet and cross added to check with the total amount. The sheet number must be filled in at the top of the sheet as each new sheet is opened (or if fly sheets are used, in the lower left corner) bearing on the top line the date and the amount brought forward. Extreme care must be exercised in making all transfers from one sheet to another, and the bottom items representing amounts carried forward must absolutely agree with the top items on the next sheets representing amounts brought forward. This includes the figures at the bottom of the weight column, as well as other amounts.

14. Every item posted on the sheet, no matter in which column, is carried over in one amount to the extreme right-hand column in total amount to form a new total. The total amount, or amount on each line reading from top to bottom, is increased over the previous one by an amount equal to the entries to the left of it on the same line.

15. All cost sheets must have a blank space of at least five lines between the last posting at the end of the month and the first entry for the ensuing month. This is done not only to separate each month's work but to facilitate monthly inventorying, and as an additional check against errors.

16. When posting material charges, either from invoices or material bought on purchase or casting purchase orders, the number of such purchase order must be checked against the number appearing on the margin of the cost sheet. This marginal column should contain the numbers of every purchase order issued, chargeable to the job in question, so that if the Cost Clerk does not find the number as a check, he must investigate to be sure the charge is authentic. As the material is received on each purchase order, a diagonal line must be run through the purchase order number in the marginal column. The object of this is to form a graphical record to assist in checking off what material has been

received. A similar notation should be made on the cost sheet for each material card issued by the planning department for all material requisitioned from stores.

17. No time must be posted to these sheets except for business and expense that does not come through the proper channel, and which does not have a work number, as well as a job number. Without both of these numbers there is no check on the correctness of the charge, and neither can the correct routing or condition of the work in the shop be told from the cost sheet, because the heavy black lines, showing its progress, will not exist. This will be further explained below under "Job Time Cards," paragraph 20.

18. Job Time Cards. The time card coupons will be sliced up and separated from the time checks before being received at the Cost Clerk's desk. The Cost Clerk should first sort these coupons, according to the jobs, so as to bring all the different classes of work together. Subsequent to this they should be sorted alphabetically by job number, after which they should be again sorted by work number maintaining at the same time their relative numerical position by job numbers. Attention is called to the fact that all work numbers across the top of the schedule cost sheets are always in numerical order, so that to expedite the Cost Clerk's work of posting, the coupons should be arranged in numerical order by work number.

19. Each job time card will bear on it the charge number, work number, man number, man rate, date, department or labor division, machine symbol, etc., all of which are to be accurately copied and posted to cost sheets in the proper order.

20. As fast as the work on each coupon is completed in the shop, it is immediately stamped "Done" in large letters. As the Cost Clerk posts each coupon marked "Done," he must be sure to extend the heavy black horizontal line at the top of the sheet the full width of the column, in which he posted the time—being sure that the work number on the coupon agrees with the work number

on the cost sheet. This line is to be ruled between the two guide lines provided, over the words "Work No.," and extending across the page. In cases where the coupon is not stamped "Done," the top of the column is not ruled off—the sole object of the heavy black line being to indicate graphically the progress of the work through the shop. As each coupon is posted on the cost sheet, it must be initialed by the Cost Clerk, showing that the entry has been made. Invoices and credit memoranda, etc., posted to the cost sheets must also be initialed by the Cost Clerk.

21. The Cost Clerk will daily, after he has posted all the time coupons, total same by classes to get at the total hours and the amount of money which he has charged to Business, Plant, Factory, Shop-Keeping and Merchandise. He will check these individual amounts and totals with the amounts entered in the daily wage distribution book by the Time Clerk, and will check the proper column with his initial to show that such time for that day has been checked and agrees. It is imperative that the daily charges of hours and money to the various cost sheets agree absolutely with the daily wage distribution.

22. Fly Sheets. When one sheet is not sufficient, one or more fly sheets may be used. The fly sheets are exactly like the first sheet except that the heading has been removed down to the bottom of the space provided for work number. The fly sheets so arranged allows the original heading on the first sheet to be used without recopying the entire routing. The job and sheet numbers should be filled in the lower left-hand corner of each fly sheet at the time it is placed in the files.

23. Recapitulation of Costs. The Cost Clerk should make it a point to daily close all cost sheets for work completed, after being sure that all the charges to these jobs have been received and posted by him. The upper left-hand corner of the sheet provides for the recapitulation of the costs. This cost includes material, labor and sundries, which totaled represents prime costs. To this,

opposite expense, must be added the prevailing over head burden per hour. This burden added to the prime cost, represents the total manufacturing cost. Differential burden or machine hour-rate is posted in each labor operation column.

24. Monthly Reports. The Cost Clerk will see that on the first of each month there are no cost sheets on his files, other than those for work in process. The completed sheets for all billed or shipped work must be moved out of the files, or allowances made in his report of work in process for partial shipments or billing. Otherwise work might appear both in the inventory and in bills or accounts receivable.

25. All cost sheets of expense (Shopkeeping or Business) are left in the files but a space left each month so that under the expense subdivision, each month's charges are clearly separated. Business and shopkeeping expense are to be listed first so that these items may be checked and compared as early after the first of the month as possible.

26. After carefully clearing his files, and checking the items mentioned above, the Cost Clerk is to tabulate in groups all work in process under the several headings—Orders, Factory (F) Jobs, Stock (L) Jobs, Merchandise (M) Jobs and Plant. (P) Jobs. This list for each of the above groups should have a separate column for material, sundries, hours, wages, expense and amount. Each different group is to be figured at the prevailing expense rate determined periodically for that group. This expense rate or burden will be specified by the Secretary-Treasurer.

27. In making up this report the Cost Clerk must be sure all charges for both material and labor are included, taking special care to see that there are no uncharged invoices which apply to that particular month.

28. Extreme care must be exercised to see that partial shipments, either on purchase or casting purchase orders are properly charged up. Generally speaking, material is not received in partial shipments, but in a few exceptional

cases, especially for large parts, this rule is departed from. This check should be made against the Receiving Clerk's copy of the purchase orders and casting purchase orders remaining on his file at the end of each month.

29. Cost Sheet File. All completed cost sheets are to be filed in the file cabinet provided for this purpose in numerical order, and in the proper compartment, as indicated by the order or job symbol.

XXI

Time Keeper's Instructions

1. Time Check. The Time Keeper's attention is called to the notice entitled Time Clock, dated Nov. 13, 1907, explaining the use of time cards and time clock and payment for regular and overtime work, which notice is to be considered a part of these instructions.

2. Time Keeper's attention is also called to memorandum dated December 15, 1908 entitled Interpretation of Time Clock Cards, which memorandum is also to be considered part of these instructions.

3. The Clock Cards are made out in the counting room, the chief clerk being responsible for the issuing of the required cards each week.

4. The Time Keeper is required to be present in the shop at the time clock from about 6.50 A.M. until after the second whistle blows and to report immediately to the Superintendent any employee who attempts to register another's card. He must also report to the Superintendent those employees who are habitually late or who are violating the shop rules pertaining to requirements for registering time.

5. The Time Keeper must note any difference of time which may exist between the time the whistle is blown and the time clock. If necessary he should signal on the shop 'phone from the Superintendent's Office to the engine man so that he may blow the whistle from the boiler room in

accordance with the time clock. This whistle should agree absolutely with the time recorder, from the cards of which the payroll is made up.

6. TIME CARDS. The hours worked must be recorded daily by the various foremen and gang bosses on job time cards, Form FAP17b (white for regular work) or Form FAP18b (red for overtime work) one of which cards will be daily issued by the time keeper for every employee in the drafting room, counting room, and planning department, as well as for all factory employees.

7. Foremen, Gang Bosses, or heads of departments are to see that the separate coupon on the time card is made out for every different job, which each of his men works on during the day. Each coupon must bear the order, work or job number, the man's number, and the time the man started and finished. He must note in the right-hand upper margin of the coupon the elapsed time, also putting a check mark in the space provided to show whether it was machine work or hand work. The machine symbol must be given as well as that of the operation, such as BO, TN, TH, AS, DM or other symbol covering the operation, or several operations, for the work done.

8. The Time Keeper must see that these time cards are received by him promptly at 7 o'clock in the morning except perhaps for over-time cards, which he must receive as soon after seven o'clock as practicable, but not later than 7.30.

9. The Time Keeper must be sure that time cards are returned every morning for every employee who worked the previous 24 hours, expiring at 7 A.M. of that date, which time cards are to be sorted by departments and handed to the planning department time boy. This boy plainly stamps the cards from the different departments with a rubber stamp with the department symbol, in the place provided on each coupon of each card. The cards are also to be plainly dated with the month, day and year in the space provided on each coupon on each card.

10. The Planning Department time boy is then to see that each coupon of every time card which bears a work number has this number crossed off by running a straight line through same with a blue pencil. The order, job or other number to which this work is to be charged must be plainly marked with blue pencil in the blank space immediately under the one provided for the work number.

11. As fast as the Planning Department time boy gets all the cards for one department or boss dated, stamped and the work numbers transposed, he passes same over to the Time Keeper, who will immediately total the various hours appearing on each coupon to see that same agrees with the total hours allowed on the time check (or top coupon) of the time card. This represents the total hours the man is supposed to have worked that date and which the foreman or boss has recognized by signing his name on the time check. The Time Keeper, after checking the hours to see that they agree with the time check, fills in the space provided in each coupon, the man's rate and the amount of wages for the time consumed as shown by each individual coupon. He carries the total amount due the man, to the time check at the top of the card; this total amount represents the man's rate multiplied by the hours shown on the time check, and of course, must equal the total of the various amounts on the coupons below.

12. Each day's time cards as soon as totaled and priced by the Time Keeper must be taken by him to the shop and each card checked off against the time clock card for each man. This is done to be sure that the total hours signed for by the man's boss or Foreman (and equaling his total distributed time) agrees with the total hours he is known to have worked, as shown by the time clock card. Any error or discrepancy between the time card and time clock card must immediately be investigated and corrected by the Time Keeper.

13. The time cards are then sliced up and each coupon cut off separately. All coupons are sorted to orders, L,

M, P, or F jobs, or to shop keeping (S) and business (B) expense. The total hours and the total money shown by the time checks is to be added and recorded in the Daily Wage Distribution book in the proper columns by job groups above mentioned. Each entry must be initialed by the Time Keeper.

14. In totaling the coupons preparatory to posting in the daily wage distribution book, the Time Keeper must use the adding machine and tape, and check same back to the coupons to be sure there is no error. This tape should be preserved until the cost clerk is through with the posting of the coupon and his additions for the distribution of time must agree absolutely with the Daily Wage Distribution Book. This checking must be done daily and the book daily checked with the cost clerk's initials to show that checking has been made.

15. Time checks from the daily time cards must be preserved by the Time Keeper for at least a week to enable him to catch any error that may exist when he totals and prices each clock time card preparatory to forwarding same to the chief clerk. He must see that these amounts agree with the daily wage distribution book total for the week.

16. Time Keeper is to daily keep a record from the chief clerk's time cards and the chief draftsman's time cards, showing the hours charged up and payable for each employee who does not ring up on the time clock, which record is to be weekly turned in to the Chief Clerk.

17. The Time Keeper has in his possession the wage rates of all employees whose time is recorded by time card and he is cautioned that these rates are absolutely confidential. His record of the same is to be preserved by him under lock and key so that access to same is not easy for those not having business with this record. The same applies to the time checks which he preserves for a week or more.

XXII

Decimal System of Time Keeping

1. Commencing Wednesday, June 1, 1910, the present method of recording time (namely hours and fractions) will be discontinued and all time on time cards, clock cards, cost sheets, etc., etc., is to be expressed in hours and tenths.

2. The disk of figures on the time clock in the western end of the machine shop which formerly printed minutes on the weekly time card has been changed so as to print hours and hundredths.

3. When the clock cards are totaled and priced the total hours are to be figured to the nearest tenth.

4. All heads of departments, foremen and gang bosses, or others who have to do with making out time cards are cautioned to read the time on the clocks to the nearest tenth hour, which tenth hour is readily determined by the relation of the minute hand to the red figures on the clock dials.

5. If a man starts a job at 7 A.M. and finished it at 8.20 o'clock, the time he completes the job will appear on the time card as 8.3, this same time going down on the next coupon for his commencement time for the next job, which, if he finished at 9.35 will be recorded at 9.6, the minute hand at this time being close to the decimal mark .6.

6. It is not desirable at present to attempt to calculate time closer than tenth hours, this bringing it sufficiently close for all practical purposes, but every one is cautioned to be sure to read to the nearest tenth mark.

7. In the Planning Department by using the decimal system the wages can be calculated much more accurately. Commencing June 1st, the amounts are to be carried out to mills; this applies to cost sheets, time cards and all other records, wage distribution, etc.

8. The cost clerks are cautioned also in posting all time to the cost sheets that the figures must be invariably carried out to mills.

9. When the May work is added up and the totals carried across the sheets in the various columns with yellow ink all hours are to be totaled May 31st into hours and decimals and not hours and fractions as formerly.

XXIII

Time Clock

1. Employees are requested to carefully read and note the following so they may work in better harmony with the Time Keeper and Paymaster, thus eliminating the trouble and annoyance due to the careless and irregular methods when registering " In and Out " at the Time Clock.

2. Be sure that the shifting lever at front of Clock is in the proper position to print the time in the right space and column. These positions are plainly marked on the clock to conform to the printing on the time card.

3. The card must be dropped into the slot provided for this purpose and allowed to rest on the stop at the bottom of the slot by its own weight only. Don't keep the hand on card and don't force the card hard down, as this alters the correct position of same in the clock so it will not register in the correct space.

4. If, after registering in the morning an employee leaves before quitting time, he must register " Going Out " in the Out column. If he returns to work again the same morning he must set the Clock to the In column for overtime and register, and when going out at noon set the Clock to register " Out " in the Overtime column. This same rule applies to the afternoon also.

5. Finally, it must be clearly understood that the Time Clock automatically shifts from A.M. to P.M. at 12.15 P.M. therefore, employees must register at noon between 12 noon and 12.15 P.M. in the Out column only and then return to the Clock after it shifts for P.M. and register in the In column for P.M.

6. If a man stays at his work after 12 o'clock noon,

or after quitting time at night, he should make a double register at 12 o'clock noon (or at quitting time at night), one in the Out column for regular time and one in the In column for overtime, and when he finishes this additional period he again registers in the Out column under " Overtime."

7. If time is put in before starting time in the morning, it should be registered in the " Overtime " column. This case also requires a double register at starting time for regular time.

8. Time registered in Saturday P.M space should always be under " Overtime."

9. These instructions refer only to the method of handling the weekly time cards and time clock, and do not in any way affect the practice established covering payment for for Overtime work. Although time cards may show a register in the " Overtime " column, it is not necessarily overtime work.

10. The basis on which straight and overtime work will be paid for is as follows:

Straight or Regular Time 7 A.M. to 12 M., 1 P.M. to 6 P.M.

Straight or Regular Time Saturday 7 A.M. to 12 M.

All other time, including legal holidays, will be paid for at the rate of $1\frac{1}{3}$ hours pay for each hour worked (except Sundays, which will be paid for on the basis of two hours' pay for each hour worked) unless special arrangements to the contrary exist in some individual cases. Legal holidays are as follows:

New Years Day.
Decoration Day.
Fourth of July.
Labor Day.
Thanksgiving Day.
Christmas.

11. In figuring payroll only Hours and Tenth Hours are considered, hence the nearest Tenth Hour is used.

12. By carefully following the above instructions a clear

and accurate record will result. Chances of error in computing the wages from the time cards each week will be reduced to a minimum, resulting in much less annoyance to both the Company and Employees.

XXIV

Schedule Clerk

When the schedule cost sheets, Plates VII and VIII are used, schedules four (4), five (5), six (6), and seven (7) are unnecessary.

1. General Instructions. The object of the different schedules Form FAP10b (Plate 11), see detailed description below, is to present a complete and up-to-date record or history of the work being done on Orders, Purchases, Mdse., and Stock Jobs. The schedules show at all times the condition of each Order or Job, and the location of the various pieces. By the graphical method employed, they make it possible to see at a glance just what operations or pieces are *not* completed.

2. The Schedule Clerk is not responsible for the following up of delayed operations *except* as regards the Purchase and Casting Purchase Schedules and promised date for *Information to be received from Engineering department on all schedules* (especially General Order Schedule). These delayed operations he is to follow up as described below.

3. The general scheme of the schedule is suggestive of a time table, the vertical row of letters at the left being the day of the week, to the right of which the date is to be put.

4. All operations *to be performed,* are noted in *red* and when done same are noted in *black.* These notations are always in ink, of the color specified and appear on the horizontal line corresponding to the date on which the operation is to be performed, or has been completed as the case may be.

5. The different schedules are as follows:
   1. General Order Schedule.
   2. Purchase Order Schedule.
   3. Casting Purchase Order Schedule.
   4. Stock (L) Job Schedule.
   5. Merchandise (M) Job Schedule.
   6. Plant Job Schedule.
   7. Factory Job Schedule.

6. All material lists, drawings, references and additions to material lists or drawings, must pass through the Schedule Clerk's hands. He must note on the proper schedule opposite the proper date, LP for every addition to the list or drawing. Thus the schedule will show a record of the frequency and number of alterations or additions. Symbol LP will be interpreted as " Listed Partially " or a change or addition to the list, and DW will be used where the change affects a drawing or drawing reference for an order or job on which there is no list.

7. Follow up Methods. Referring to above General Instructions, Paragraph 2, the Schedule Clerk must understand that he is responsible for following up all items on both the Purchase and Casting Purchase Schedules and is furthermore responsible for following up items on all other schedules as far as the *information to* be received from the Engineering Department is concerned. All urgers pertaining to information must be made daily in the form of a written list, which list is to be handed directly to the Superintendent.

8. The Schedule Clerk is held responsible for the condition of the schedules and for keeping the work up to date. Special attention is called to the importance of following up systematically by means of written urgers on the three schedules above mentioned, the condition of all items for which the Schedule Clerk is responsible. Every urger on either of the three above mentioned schedules, whether verbal or written *must* be noted in black (UR) on the proper schedule, or in the proper column and opposite the proper

date so as to fix beyond question the responsibility for the non-arrival of material or information after same has once been promised.

9. General Order Schedule. This schedule in many ways differs from the others described as it is intended to form the general record or history of the order in a broad way, and not with the complete detail required on the other schedules. A majority of the orders (in number) are for repair or miscellaneous work. The intention is to denote the general condition rather than a detailed record of pieces, on such jobs as are not built on " M " or " L " Jobs.

10. There are exceptions where an order may require considerable detail. In such cases the intention is to list the various items and show their routing as explained under the Merchandise Job Schedule and in these cases the routine work is practically the same.

11. As soon as the general order reaches the Planning Department, it is to be scheduled. The proper headings are filled in, and the time of the day noted in the columns opposite the proper date line, the symbol OR in *black* denoting it has been ordered. Lower down in the same vertical column, symbol SH in *red* appears on the horizontal line corresponding to the date *it is to be shipped.*

12. Other notations are to go into this schedule as details are planned for or determined on. For instance, if the Engineering Department promises a partial list at a future date, LP in *red* is noted opposite the date; or similarly, if the list complete is promised, LC in *red* goes opposite that date, and on the other hand when such information is received, the same symbol goes on opposite the date on which the information reaches the Planning Department, but in *black*. The scheme on all the schedules is to have all operations or acts *to be performed* noted opposite the dates of such performance in *red*. When an operation has been completed, the same symbol is used but in *black ink*. The difference in color indicates at a glance whether it is a future or past record.

13. Details of General Order and Order Job Schedule. As soon as a General Order reaches the Planning Department it goes to the Production Clerk, who notes on the face of the order in *red* the job or expense number to which charges are to be made, if not to the order number itself. The Production Clerk then promptly passes the original order to the Schedule Clerk, who must immediately enter it on the schedule as ordered (OR) and the time it is scheduled, both in *black* ink.

14. Mark the General Order itself with the schedule stamp, showing it has been through the schedule and pass to the Routing Clerk.

15. The Chief Draftsman will give the Schedule Clerk dates on which information from the Engineering Department is due. Such information, if not received on the date promised, is to be urged daily by the Schedule Clerk. " UR " is noted on schedule each time material or person is urged, thus placing the responsibility for delays.

16. The symbols LP and LC denote List Partially and List Complete. In such small orders as repairs or Stock Jobs not having a material list, they will be interpreted as showing Information Partial or Information Complete.

17. The Shipping Date will be furnished by the Superintendent if the original General Order does not have it when issued, and appears opposite proper date as SH in red.

18. When a General Order is shipped, the Shipping Clerk passes same to the Production Clerk, who after making the necessary closures in his Job Book, passes same to the Schedule Clerk. The latter sees that the Schedule for the order or job is closed, and when possible that the sheets are removed from the schedule file. The General Order then goes to the Cost Clerk.

19. Details of Purchase Order Schedule. A requisition as soon as made, after inspection by the Production Clerk, goes to the Stores Clerk to be checked against the stores account, then goes to the Schedule Clerk, who enters

same on the Purchase Order Schedule, noting to what job it is charged and transposing the work number when one is used. He notes his receipt of the requisition RN in *black* opposite the date on which he first received it and enters in *red* wanted WT opposite the date material is needed. He then gives it to an errand boy who at once takes it to the Superintendent, Assistant Superintendent or Organizing Engineer for approval and then delivers it to the Purchasing Agent.

20. After the Purchase Order is issued the requisition is returned to the Schedule Clerk, who notes on schedule the P. O. number and date ordered which have been filled in by the Purchasing Department.

If not for stock it then goes from the Schedule Clerk to the person who issued it, but if the requisition is for stock material, it goes to the Stores Clerk, and then to the person who originally issued it.

21. The Receiving Clerk's copy (blue) of purchase order also goes to Schedule Clerk, who compares same with original requisition, exercising care to see that the two agree and that destination of material called for is clearly shown on P.O.; it is then forwarded to the Receiving Clerk.

22. All invoices for all Purchases go to the Schedule Clerk who under the date of invoice noted "IN" on schedule. If invoice is not marked with P.O. number he refers same to Production Clerk, after which the invoice and P.O. is passed to Stores Clerk (if for stock) or to Cost Clerk if not for stock.

23. When material is received the Receiving Clerk's copy of the P.O. is properly filled out by him and sent to Schedule Clerk, who notes RE under the proper date for such items as are received and if shipment is complete, the P.O. is attached to invoice and forwarded as explained above. If invoice has not been received, P.O. is held by Schedule Clerk until same arrives. The same routine is followed for all purchase orders on which part only of the material called for has been received.

24. The Schedule Clerk is to urge all delayed P.O. invoices or material (after Date Wanted expires) through the Purchasing Agent.

As a result of " UR " or otherwise, all promised dates are noted on schedule in *red*, SH showing when the vendor expects to ship. When shipment has actually been made, SH goes on in *black*. When material arrives RE is noted in *black*.

25. In addition to marking RE on P.O. schedule, all articles received for work in process (not going into Stores) should be marked RE on the schedule for such order or job. The next work order in routing rack should be moved up to the second compartment showing material is RE (the Receiving Clerk already having changed the shop rack).

26. Details of Casting Purchase Schedule. This schedule is generally speaking similar to the Purchase Order Schedule.

27. Casting Purchase orders are issued only by the Planning Department. The yellow copy goes at once to the Schedule Clerk, who makes the proper heading notes opposite the dates " OR " ordered and " WT " wanted. The latter is noted in *red* ink. When castings are received RE in *black* is also added to the schedule.

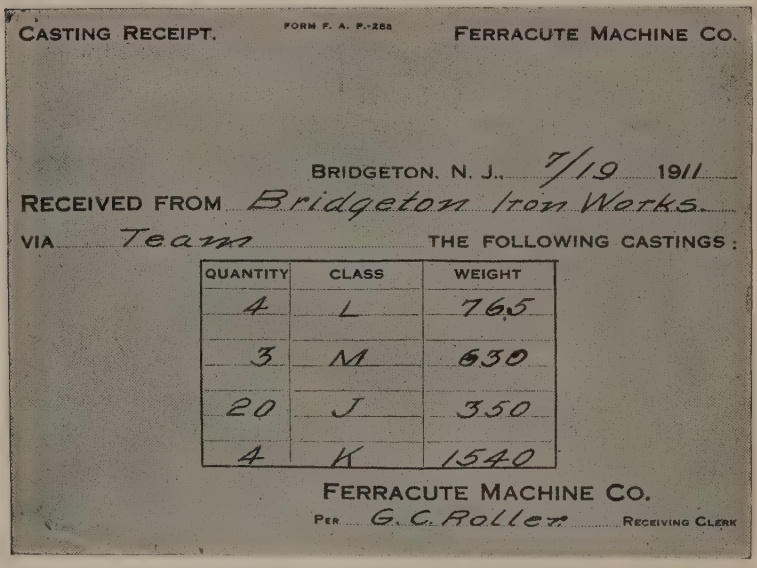
28. The yellow casting purchase order is then sent to the Pattern Shop. When pattern goes to the foundry PF is noted on the schedule.

29. Urgings of castings overdue are started by means of a list made out daily by the Schedule Clerk and passed to the Production Clerk, who will urge Foundry. He returns the memorandum to Schedule Clerk, who notes on schedule new delivery dates.

30. The Casting Purchase Orders for each load of castings come to the Schedule Clerk in duplicate, viz., the White (original) and Blue (Receiving Clerk's) copies. All orders representing one load go together with the pink casting receipt Form FAP28a, showing the total pounds of castings under each class received.

31. The Schedule Clerk is to note on back of such casting receipt the Casting Purchase Numbers and their weights which go to make up the pounds received of *each class* of castings called for by such receipt. This casting receipt is then forwarded at once to the Counting Room. See Fig. 45.

32. On the back of Casting Receipt a notation must be made denoting those to be charged to Plant, Factory,



CASTING RECEIPT. FORM F. A. P.-268 FERRACUTE MACHINE CO.

BRIDGETON, N. J., 7/19 1911

RECEIVED FROM Bridgeton Iron Works.

VIA Team THE FOLLOWING CASTINGS:

QUANTITY	CLASS	WEIGHT
4	L	765
3	M	630
20	J	350
4	K	1540

FERRACUTE MACHINE CO.

PER G. C. Roller RECEIVING CLERK

FIG. 45.—Casting receipt. This forms a record of each load of castings, by classes.

Business, or Shopkeeping by putting the initial "P," "F," "B," or "S" as the case may be, opposite such items, with the correct weight.

33. White copy of the casting purchase order is to be promptly posted to the casting purchase schedule (after checking weight and grade with Casting Receipt) showing opposite the date and in the proper column the quantity of castings received. If the order is filled, the foot of the column should be ruled to show the item is complete, after

which the white copy goes to the Cost Clerk, if such orders apply to Work in Process for Plant, Shopkeeping, or Factory. If it is for castings going into rough stock, the white copy of the casting purchase order is then forwarded to Stores Clerk.

34. In addition to marking RE on Casting purchase schedule, all articles received for work in process (not put to stores) should be noted as RE on the schedule for such order or job. The next work form in the Routing Rack should be moved up to the second compartment showing the material is RE. The Receiving Clerk has already changed the shop rack.

35. The Blue and Yellow copies of Casting Purchase Order remain on file in Planning Department.

36. Details of Stock "L" Job Schedule. The object of this schedule is to record the condition of the various "L" jobs in process. The detail use of same and the method of noting various conditions of the work as it progresses, from the next work and move material forms, is the same as the M job schedule described above.

37. The heading across the top of this schedule differs from the "M" job schedule in that the "L" job numbers on which the piece is being made heads the vertical column in which the name of such piece appears. The subsequent columns to the right of the first one are for each successive operation. The "L" number and name of piece is not filled in, in each of these subsequent columns but is dittoed across from left to right.

38. When an "L" job is completed as evidenced by the schedule, the same should be reported by Schedule Clerk to Production Clerk, who will see that the Department Order on file in the Planning Department is properly closed and passed to the Stores Clerk.

39. Details of Factory "F" Job Schedule. This schedule will be practically identical in method of handling, etc., with the Plant Schedule above described.

40. Details of Merchandise "M" Jobs Schedule. This schedule is intended to record the condition of all work in process such as machines, etc., which are coming through on Merchandise or "M" jobs. Each item called for on such job, as per material list, is entered across the top of the schedule. Each item has all its operations consecutively listed before the next item is listed. The various operations show separately in what departments, machines, etc., each is to be done. This is posted to the "M" job schedule from the Work Orders, after the Routing Clerks have routed the job.

41. When the shop copies of the next work form are completed they are returned immediately to the Planning Department. After the Route Rack has been changed, they go at once to the Schedule Clerk, who notes on the Schedule in the proper column that such operation is completed by putting its operation symbol on the schedule in black on the horizontal line corresponding to the date on which such operation was completed. He notes in the next operation column under the proper work number the symbol "MM" showing that the material has been moved to its next position by the "Move To" direction on the face of the next work form.

42. When certain moving of material is done in the shop *not in connection with the next work form* the move material order Form FAP9a is used and notations from these forms, when they return to the Planning Department, are to be made on the schedule showing the movement of the material.

43. Every vertical column (as soon as the operation is complete) must be horizontally ruled off in black at the bottom as the object of this black line across the bottom of schedule sheet. This is to show at a glance whether all the operations called for on said sheet are complete or not, as evidenced by whether the line is a continuous line across the page or whether it is a broken line, such breaks or omissions indicating certain operations uncompleted.

44. When an " M " job is closed, schedule should be closed up, see Paragraph 6, under " Detail of General Order and Order Job Schedule," above.

XXV

Factory Mail System

1. The Factory Mail System is a method of promptly and cheaply handling all inter-department business. It does away with a large percentage of annoyance and great loss of valuable time which exists where each officer or head of department has to personally do his own errands.

2. Each Mail box is numbered and located as follows:

No. 1. President's Office.
2. Assistant Engineer Office.
3. Die Engineer.
4. Vice President's Office.
5. Secretary's Office.
6. Chief Clerk.
7. Schedule Clerk.
8. Routing Clerk.
9. Shipping Clerk.
10. Pattern Foreman.
11. Carpenter Foreman.
12. Power Plant.
13. Forge Shop Foreman.
14. Store Keeper.
15. Material Foreman.
16. Press Shop Gang Bosses.
17. Die Foreman.
18. Tool Foreman.
19. Superintendent.
20. Painting and Cleaning Department.
21. President's Residence.
22. Production Clerk.

23. Erecting Boss.
24. Order-of-Work Clerk.
25. Cost Clerk.
26. Stores Clerk.

3. The Factory Mail boy will deliver mail to, and collect mail from each box every fifteen minutes, commencing 7 A.M. The last morning trip will be at 11.45 A.M. The afternoon trips will commence at 1 P.M. and the last trip be at 5.45 P.M.

4. The Mail Boy is under the Production Clerk and waits in the Planning Department after completing his round until time to start on the next trip, which he makes in the following order:

No. 7. Schedule Clerk.
8. Routing Clerks.
24. Order of Work Clerk.
22. Production Clerk.
26. Stores Clerk.
25. Cost Clerk.
9. Shipping Clerk.
1. President's Office (Ingoing mail only).
2. Assistant Engineer Office.
3. Die Engineer.
4. Vice President's Office.
5. Secretary's Office.
6. Chief Clerk.
10. Pattern Foreman.
11. Carpenter Foreman.
12. Power Plant.
13. Forge Shop Foreman.
23. Erecting Boss.
14. Stores keeper.
20. Painting and Cleaning Department.
16. Press Shop Gang Bosses.
15. Material Foreman.

15. Die Foreman.
18. Tool Foreman.
19. Superintendent.
21. President's Residence (not used at present).

XXVI

Inspector

The following constitutes the authority and instructions by which the Inspector will be governed:

1. Foremen and Gang Bosses are instructed to familiarize themselves with same so as to avoid misunderstandings and to in all ways possible work in harmony with and assist the inspector in an effort to improve the standard and quality of all work.

2. Patterns. The Inspector will measure all new or altered patterns previous to their going to the foundry and on any large, intricate or otherwise unusual work, will consult with the Superintendent before passing same.

3. See that sufficient finish is allowed and that pattern and core-boxes, core-prints, etc., check to the drawings, and that otherwise the patterns are made to the instructions regarding patterns to which the Pattern Foreman is instructed to work.

4. Castings. Castings when received are to be inspected to determine their general condition, including:

A. Proper cleaning and snagging at the foundry.
B. Cores properly removed.
C. Properly molded and faced.
D. Free from detrimental sand, blow or shrink holes.
E. Cold short or shrink cracks, especially spokes of wheels (which he will determine by sounding with hammers).
F. Warping or other errors from pattern.
G. Shifting Cores.
H. That test coupons are intact.
I. That no filling, painting or caulking has been done to cover defects.

J. On special or doubtful pieces have same surveyed and checked by pattern to determine if shrink and finish allowances are sufficiently correct.

K. If steel castings, see that they are annealed properly.

5. Forgings. Forgings or rough turned work should be carefully examined for:

1. Piping (will show at center of ends).
2. Seams.
3. Faulty Welds.
4. And to see that pieces will finish to drawing and specification.
5. That material is as ordered.

6. Miscellaneous Purchases. Miscellaneous commercial articles purchased outside must not be accepted by the Receiving Clerk until inspected and passed by the Inspector. The Inspector will see that all such material, supplies, etc., not otherwise covered by these instructions is received in good condition, agrees with purchase order and checks up as to dimension, number, unit, weight or other means requisite to accept or condemn for the purposes they were intended for when purchased, without an expense to Ferracute Machine Company, not originally contemplated as part of their cost.

7. Cleaning Department. The Inspector will see that all castings before reaching the erecting floor or shipping floor are properly shipped and cleaned as per instructions.

8. Painting and Filling. The Inspector will likewise give the same attention to the painting and filling covered in instructions to date.

9. Machine and Hand Operations. The Inspector will check and inspect all work as it leaves each successive machine or bench so as to prevent additional outlay of labor and time on spoiled work, and furthermore to place the responsibility and blame at once. This continuous inspection saves time later on erecting or shipping floor.

10. Laying Out. Laying out is as distinctly an operation as drilling a hole and must be inspected and approved

before operator proceeds with the machining of the piece in question.

11. Batches. Work coming through in batches must be carefully watched at the different machines and the first piece of each batch inspected and tried to gage, machine or other piece or pieces it is to be assembled with to make sure it is right before proceeding with the rest of the batch. This is particularly important and should be watched closely as we are continually making larger quantities in batches and are getting nearer the interchangeable basis. If the first piece is wrong and passes inspection, all the remainder of the batch will be wrong.

12. Quality of Finish. The quality of finish as done by the various machines must be the best possible for the purpose, or best obtainable with the machines available.

13. General Appearance. The general appearance of all work is often of equal importance to the accuracy of the finish of the assembled article, and parts to be finished or polished simply for looks should be looked out for. This must not be carried to excess or done at unreasonable expense. Proper and careful filing and painting especially, takes but little longer than hurried work and adds 100 per cent to the looks of a machine generally.

14. Rejects. Work not done to drawings, when not condemned must be brought to the attention of both the foreman (or gang boss) in charge of the work, and the Superintendent, and a record of each case sent to the Engineering Department of the variation from drawing. In such cases look out for interferences.

15. Condemned parts, due to faulty work, must be replaced. The net additional cost of such replacement is to be charged to the "Bad Work Expense" number of the Department, foreman or gang boss responsible; this will be attended to by the Planning Department. All condemnations are to be reported on the Inspector's Condemnation Report, Fig. 8, Chapter III.

16. Rejects due to material found defective after

machining operations are started must be reported immediately to the Planning Department. Means will be taken to adjust the charges and order replace pieces. This also applies to material condemned before machining operations commence.

17. On work condemned the Inspector will order the Gang Boss or foreman in charge to stop the work at once, close up the time on the work order to the point at which piece is condemned and immediately start the man on a new job.

18. Clearance and Tolerance Table. All detail drawings will have clearances and tolerances marked for all dimensions, including diameters for male and female Fits.

19. The Inspector, in addition to checking the figured allowances he finds marked on drawings, will in inspecting and measuring work endeavor to see that clearances not provided for on drawings (but which must be allowed before work can be assembled) are made at the machines and not left for the erecting gang to do by hand.

20. Assembled Work. During assembling see that machined parts go together properly with a minimum of fitting and that scraping and handwork done on the floor is not to correct improper or faulty machining, but rather to improve (if necessary) the surface or finish to the state required by the conditions covering the various work.

21. See that parts put together have been properly fitted; that little or no scraping be done on surfaces that do not slide or revolve on each other, except to make flat. Reamed holes cannot be improved by scraping.

22. See that working or moving parts are free from "Bind," work easy and are not so loose as to shake or rattle.

23. See that flat surfaces are scraped or finished true and flat, and that holes are reamed (not scraped) in every instance where a reamer can be used.

24. After a machine is assembled it should be inspected to see that

A. Gearing runs properly.

B. That all adjustments are operative, free from bind and as intended; both hand and power.

C. On small presses that ram and bed are flat and parallel within .001″ to .002″ and that large presses from 100 tons' capacity up are parallel within .002″ to .010″ depending on the width of the press in question.

25. Test. All machines are to be inspected at the end of their five-hour test for heating, wear, breakage, etc., and the time of the test may be continued until the inspector is satisfied with machine.

26. Drawings. The above instructions cover those points to be watched by the Inspector and are not to be interpreted contrary to the detail and assembled drawings covering the different work. Drawings are in all cases to followed, unless errors or omissions are discovered which the inspector will report to the Engineering Department and he must abide by the decision of the engineers.

27. Authority. The Inspector's word is final and he is under orders from the Superintendent or Assistant Superintendent only.

XXVII

Stores Keeper

1. The duties of the Stores Keeper include:

2. The charge of all material, supplies, rough and finished parts, lumber and stationery wherever located. He will be responsible for the proper custody of same. Everything as above described will come under the one name of stores. The main stores room will be located in the machine shop on the north side of the building at which place the stores keeper will make his headquarters. In addition to the main stores room, there will be sub-stores rooms for such stores as cannot (at the present at least) be properly cared for and distributed from the main stores

room, such as lumber, iron and steel, rough castings, paints and oils, stationery, etc.

3. As the stores department grows the stores keeper will be furnished with such assistance as the proper handling of his department will require.

4. A stores ledger will be kept in the Planning Department on the card system giving an accurate record of all stores and their value, which amount is charged to the stores department. It is necessary and important that not even the smallest object be delivered from stores without a written order on material card Form FAP6 (Fig. 19, Chapter V) properly charging such object to either an order, job, item or work number, and at the same time crediting stores with same. The Stores Keeper must accept no material card unless it is properly filled out and signed by the Superintendent, a Foreman, the head of any department, or the engine man.

5. The Stores Keeper after delivering the material called for on such material card then fills in the section and space numbers and signs his name so that the material card then appears complete.

6. The material card is then given a reference number and forwarded to the Planning Room. If a material card is presented to the Stores Keeper calling for material which is not in stock the Stores Keeper immediately forwards a requisition Form FAP13 (Fig. 2, Chapter II) to the Planning Department for the material wanted, holding the material card until the material called for is received. The material on arrival is then delivered at once without further order to the person or department requiring it.

7. All material received by the Stores Keeper must be signed for on material card made out by the Stores Keeper. This material card is the necessary notification to the Stores Clerk that the material has been received into the stores department. Under no circumstances must stores wherever located be taken or used without the knowledge of the Stores Keeper or the required order on material card Form FAP6.

XXVIII

Tool Foreman's Instructions

1. Referring to the Organization Chart the Tool Foreman is in charge of the Tool Department. In addition to the machine tools listed as under his direct charge in his department, he also has direct charge of the operation of the following:

A. One 20-ton Niles Crane.

B. One 10-ton Pawling and Harnischferger Crane.

C. Two 5-ton Niles Cranes.

D. One 5-ton Hand Crane.

2. The janitors and watchmen also belong to his department. The Locker Room and Power plant are in charge his and include:

E. One 250-H.P. Heine Boiler.

F. Two 75-K.W. direct connected generators.

G. All electrical equipment, and maintenance thereof, throughout the entire Plant, all heat, light and ventilating equipment.

H. Power equipment and the maintenance thereof throughout the entire Plant.

3. The maintenance of Plant, Land and Buildings, etc., coming under the direct charge of the Superintendent will be done by the Tool Foreman, but under special orders from the Superintendent through the Planning Department.

4. The Tool Foreman has one assistant known as the Assistant Tool Foreman. The Assistant Tool Foreman assumes the duties of the Tool Foreman whenever he is absent. In case of emergency when the Tool Foreman cannot immediately be located the Assistant Tool Foreman must act for him. He must become familiar with these instructions so that whenever the duties fall upon him, he cannot plead ignorance of his responsibilities.

5. Drawings, Blueprints, etc., are to be considered as tools and kept in the files provided in the Tool Room for that purpose. The method of handling them is described

in the " Shop Drawing Boy's Instructions," which instructions are to be considered as part of these instructions. It is to be understood that throughout this set of instructions the term " tools " is to include drawings, blueprints, sketches, bonus charts, jigs, tackle or other rigging used in the manufacture of the firm's product and coming under the care of the Tool Foreman.

6. The Tool Room proper is divided into two sections, one of which is known as the Storage Section (see Fig. 22, Chapter VI) and the other the Maintenance Section (see Fig. 21, Chapter VI). The Storage Section of the Tool Room is in direct charge of the Tool Keeper who is the special assistant to the Tool Foreman. The Tool Keeper's instructions are considered as part of *these* instructions. The maintenance section of the Tool Room is in immediate charge of the Tool Foreman.

7. The Tool Foreman is to maintain a check system and provide in the Storage Section of the Tool Room proper clips or holders so that each tool may have a proper place, and a clip or holder at each place to keep the check belonging to the man to whom such tool was issued. Ten brass checks in a snap-ring are to be issued to each workman likely to require tools from the Tool Room including Gang Bosses and Foremen. In some cases it may be desirable to issue more than ten checks to a man, in which case more may be issued at the discretion of the Tool Foreman. In issuing more than ten checks, the Tool Foreman must issue either 15 or 20 rather than a quantity not a multiple of five.

8. Each man must keep his own checks and he will be held absolutely responsible for them and will be charged for those lost. No tools are to be issued to any one without a check to be exchanged with the Tool Keeper for the tools issued. The Tool Foreman should have a special set of checks of his own so that if he or others in authority require tools and they are not regularly supplied with checks, they may obtain them from the Tool Foreman. The object of

this is to enable the Superintendent or Assistant Superintendent (or others not ordinarily using checks) to get tools whenever necessary. In such cases the Tool Foreman is directly responsible to see that these tools are promptly returned and the check returned to him.

9. Special attention is called to the use of certain special tools, including tools made for some special work, or tools particularly accurate and delicate, and which are intended to be used only for certain specific jobs. These include also reamers and other accurate tools furnished solely for use on bronze or other similar metals; not iron, steel, gun-iron, etc. In such cases, these tools are to be issued only on Foreman or Gang-Boss check. Special attention is to be given to the inspection of such tools on their return to the Tool Room, and the Gang Boss or Foreman to whom they are issued is held responsible for their being used safely and carefully. No excuses will be accepted for the misuse of these special tools covered in this paragraph. These tools last mentioned are to have a large metal tag fastened to them clearly stating what metals they are to be used for.

10. If a person loans a tool which he has drawn out on his own check to another he does so on his own responsibility, as the man having the check number which agrees with the check on file in the Tool Room will be responsible for the tool in question.

11. The Tool Foreman (as well as his assistant) acts in the capacity of a functional Foreman. As such they have authority to stop the abuse, or misuse, of tools in the Shop while they are in the hands of men in other Departments. This does not for a moment detract from the initial responsibility of the Foreman, Gang Bosses and the men using such tools. It means that where a Tool Foreman, or his Assistant, sees a tool misused, or has reason to believe that the tool will not have proper use when issued, they can take steps to prevent its being damaged.

12. Pay special attention to the following shop rules:

Rule 9, *Locker Room*

All washing is to be done in the Locker Room and employees are required to keep their extra clothing, hats, shoes, overalls, umbrellas, dinner-baskets and all other private property (except tools) in the lockers assigned to them. These being equipped with a convenient combination lock, should always be kept locked.

Rule 10, *Condition of Tools*

All employees must report to their Foreman the faulty condition of tools, machines or other equipment with which they are working. The Foreman must immediately report the same to the Tool Foreman and if not put in proper shape in the shortest reasonable time must again report to the Superintendent.

Rule 11, *Spoiled Work*

An undue amount of spoiled work or breakage or misuse of tools and other equipment will not be tolerated.

Rule 14, *Discipline*

Employees intentionally breaking the rules of the Company are liable to suspension or discharge. If suspended, it will be for a period left to the discretion of the Superintendent, after which time the employee may return to work.

If an employee is discharged, he will receive what pay is due him at once, if during office-hours, but if at any other than office-hours, his pay will be available for him as soon as the office opens, such pay counting up to the time of discharge.

Employees discharged for lack of work will be given one week's notice; the management requires them to do likewise when it is their intention to leave. Employees leaving without a week's notice will receive back pay due them the days on which it would be regularly paid.

Employees being paid off and leaving our employ, must return all Ferracute tools in their possession to the Tool Room and no man will receive his pay until all property belonging to the Company is returned in good condition, or indebtedness to the Company is liquidated.

Men being laid off, discharged or quitting of their own volition must be cleared from the Tool Room before receiving the wages due them.

13. The Tool Foreman is to see that no work is done in his department unless he has a Departmental or Next Work Order, except work which is regular routine work and applies to a shop expense number. Though he may be instructed by those in authority over him to do certain work he must first obtain the proper Next Work Order from the Production Clerk before proceeding. In such cases he must take the matter up personally with the Production Clerk so there will be no mistake in creating a proper job number or in distributing the time to an already existing order.

14. The Planning Department in analyzing and routing every piece of work (or on notice from the Engineering or Drawing Rooms) must provide, where necessary, orders for the Tool Foreman to enable him to get ready any special tools which may be necessary to properly machine the piece. This applies to either a special tool that must be made, or one that should be ordered. If the Tool Foreman on receipt of this order does not thoroughly understand what is wanted, he must consult the Shop Engineer, or Assistant Superintendent, who will give him whatever assistance is necessary.

15. The Tool Foreman is not responsible for getting out tools for work in process through the Shop unless he has a written order through the proper channel. Again, as above stated, he must do no work without such order. He is referred to the "General Instructions Regarding Tool Requirements," which are considered part of these instructions.

16. The Tool Keeper is to keep a correct index which will be provided for him called a " Damaged Tool Record." There will be a card in this box for every employee in the Shop charged with a check number. The card will show the employee's name as well as his check number. Every instance of unnecessary damage, loss, or wear of a tool is to be noted on the card, giving the date, the tool and the extent of the damage in hours' labor necessary to repair it. In the case of a broken tool the item is to be noted and the value of the tool marked rather than the time. The Tool Foreman is to take this matter up personally every fortnight with the Assistant Superintendent who will report at the Board Meeting the next morning in full, giving each man's name, number and an itemized account of each tool damaged by him during the previous two weeks. This report will be copied in full in the Board minutes. The Shop Engineer and the Assistant Superintendent will furthermore keep a loose-leaf book record giving a summary to be filled in fortnightly under each man's name with the above information. This book is to be kept up to date so that a report of tools damaged by any one can be obtained instantly. This summary will also be fully reported on at the Board Meeting every month.

17. A typewritten list, under a glass and framed, is to be hung in a convenient place in the Storage Section of the Tool Room giving the check number and the name of each man in the Shop to whom checks have been issued and the quantity. The Tool Foreman must see that this list is kept up to date and in a clean and neat manner. This must be changed every time a check number is changed, or a new man added to the force, as well as when a man leaves. This list should have the following memorandum at the bottom " Revised List to Date " (followed by the date revised).

18. All tools are to be symbolized. The symbols may be obtained from the Assistant Superintendent.

19. Special attention must be given to reporting at

once to the Planning Department any change in the book of Standards for Tools. This record must be kept up to date and as fast as any change is reported to the Production Clerk he will see that the Chief Draftsman is notified so the master record or negative, as well as the B–P copies, may be corrected. In connection with these changes and additions the Perpetual Tool Inventory on file must be kept up to date by the Production Clerk.

20. The Tool Foreman must keep all machines and other equipment in good operative condition. He must exercise due judgment in making repairs, working his force day and night when conditions require it. He must watch machines which are known to be in other than good condition and see that they are shut down for repairs before such faulty condition becomes too serious. Considerable breakage and expensive shut-downs can often be avoided by a little foresight.

21. The Tool Foreman should make a systematic inspection of all equipment under his charge at least once every two weeks. Shut machines down at once when their condition becomes (or is likely to become) such as to handicap production, lower the quality of work or increase its cost due to such condition. Consult with the Superintendent and Assistant Superintendent whenever there is any question as to what course to follow.

XXIX

General Instructions Regarding Tool Requirements

1. These instructions are issued for the general notification of the Heads of all Departments as to the manner to be followed from now on in providing for new or special tools.

2. In almost every instance the fact that new or special tools will be required should become known first in the Drafting Room. By referring to the book of standards it can always be known at once whether a new tool will be

required, or not. If there is any uncertainty about this the Assistant Superintendent, or Shop Engineer, should be consulted. In the event that a new tool is required, notice should be sent by the Chief Draftsman to the Production Clerk advising him of the fact as soon as it is known. The Production Clerk will then take the matter up direct with both the Routing Clerk and the Assistant Superintendent and provide the necessary orders on the Tool Department to insure the tool being made promptly and in sufficient time. These orders must clearly state a definite date on which the tool in question is to be finished.

3. The above instructions also apply to the special tools, etc., required for work for which the Die Engineer is responsible; in such cases the Die Engineer will notify the Production Clerk as above provided.

4. The Route Clerk when routing every piece of work must bear in mind the matter of special tools, etc., and as a check on the items covered above he should consult his book of standards, or consult with the Assistant Superintendent if there is any doubt in his mind as to whether such tools are on hand or being provided. In the majority of cases, his record of the tools that he has ordered as per the Schedule Cost Sheet will straighten this point out or by a glance at the work orders in the Tool Department section of the Route Rack. This is mentioned in this way, however, to guard against possible error in overlooking a tool which might have been requisitioned for purchase outside.

5. The Gang Boss and Foremen on receipt of Work Orders should check them over carefully in anticipation of any special job. Any work not standard should be looked into at once and a drawing obtained so that whatever planning may be necessary on the part of the Shop may be done prior to and well ahead of the job and before the material arrives. In most cases there will be ample time for this, including consultation with the Tool Foreman as to the special tools under way for the job. The large percentage of work orders are in the Shop Rack for weeks

and sometimes for a month or two before the material arrives, or before it is ready to be machined. There is generally ample time for the Gang Bosses and Foremen to get together with the Tool Foreman with the idea of expediting as much as possible all the work in process.

6. The Tool Foreman and other Foremen and Gang Bosses should freely consult each other and the Production Clerk, as fast as new Work Orders are received so they may work in harmony and to a definite end.

XXX

Instructions for the Care and Storage of Tools

1. The Tool Room is divided in two sections; one being for storage and the other for maintenance of tools, jigs, etc. The storage section is in direct charge of the Tool Keeper who as such is a representative of the Tool Room Foreman as far as this branch of the department is concerned. The Tool Keeper is responsible for the care of all tools returned to his department and he is not to accept from the Shop, or the other department of the Tool Room, tools which are not in good condition, except by reporting the same to the Tool Room Foreman. This, of course, does not apply to tools showing a reasonable amount of wear which regrinding will correct; the tool keeper will see that these are passed to the maintenance department for grinding.

2. These instructions are not intended to restrict the efficiency of the Tool Room as a department but rather to increase same by having *all* the tools *ready and in proper condition when wanted.*

3. The Tool Keeper is absolutely responsible for the storage section of the Tool Room and he must not allow the workmen access to the same unless he requires their assistance in getting certain tools. This applies also to Tool Room employees. If tools are returned from the main-

tenance Department of the Tool Room to the Tool Keeper and are not in satisfactory condition he must refuse to accept them and report same to the Tool Room Foreman. No one is to have access to the Storage section of the Tool Room racks without permission of the Tool Keeper, and such permission does not reduce the Tool Keeper's responsibility.

4. Finally, all Foremen and Gang Bosses must see that tools, jigs, etc., returned to the Tool Room are wiped free from chips, dirt or undue accumulation of oil and grease. In fact, the tools and jigs must be returned clean so they can be conveniently handled and stored without presenting an untidy appearance and so their condition can readily be seen at a glance. The Tool Keeper will refuse to receive tools returned to him in any other condition.

5. Violation of these instructions will place the Tool Keeper liable to immediate discharge without notice.

XXXI

Shop Drawing Boys' Instructions

1. The Shop Drawing Boy is to be one of the Tool Room Force, and will, therefore, come under the jurisdiction of the Tool Foreman. Boy No. 1 is to be stationed during his spare moments in the Press Shop on the raised platform provided for the Gang Bosses and Material Foremen. The boy is to remain on this platform when not employed carrying on his routine duties, and is not to linger on the floor with the men, or around the machines.

2. The First boy will be known as Drawing Boy, No. 1; he is to provide drawings for the Gang Bosses Paullin and McCullough, and is to work in that part of the Shop under the jurisdiction of these two men.

Drawing Boy No. 2 may eventually be employed in the Die Shop.

Drawing Boy No. 3 may eventually be employed for the use of the Erecting Floor.

Drawing Boy No. 4 will eventually be employed for the use of the Forge Shop.

Drawing Boy No. 5 will eventually be employed for the use of the Pattern and Carpenter Shops.

3. It is understood that these instructions are referring now particularly to the Drawing Boy No. 1. It is also understood that in spirit they cover the instructions for all of these Drawing Boys as soon as the volume of business or the condition of the work warrants their being employed for this purpose. These instructions also, of course, apply even though a boy is otherwise employed and is used intermittently as a Drawing Boy in any of these Departments.

4. Drawings, including Blueprints, etc., as well as Bonus Charts, are to be considered tools. As such they are to be kept on file in properly classified numerical order in the Tool Room. The proper filing cabinets have been provided for this purpose.

5. A slate is to be provided by the Tool Foreman for each file case, including that one holding Bonus Charts. This slate is to have a proper heading similar to that shown below:

BONUS CHARTS OUT

DATE CHART NO. ISSUED TO ISSUED BY

---

6. The above indicates how the top of the slate for the Bonus Charts would be made out. For sketches, the only difference would be that it would read "SKETCHES OUT" and the second column would be headed "SKETCH NUMBER."

7. Each file for drawings is to have its own slate, which slate is to be marked for example "C–DRAWINGS OUT" and the second column would be headed the drawing number; a separate slate is to be kept for each size of drawing.

8. These Drawings, Sketches, Charts, etc., are to be under the direct supervision of the Tool Foreman and the boy will be held immediately responsible by him. Blue-

prints, Drawings, Charts, etc., must not remain out in the Shop after the work has been completed and inspected. The Drawing Boy will be resposible for each Drawing or Blueprint issued by him until it is returned to the files.

9. Foremen, Bosses or others requiring drawings from the Tool Room are not to go to the Tool Room for them personally but are to send a Drawing Boy. The Drawing Boy must keep in touch with the Bosses in the Department in which he is employed so that they may anticipate their requirements for drawings and give him ample time to locate them so they may be ready by the time the job for which they should be used is started.

10. The original drawings are not to be kept in the Tool Room but can be obtained only through the Drafting Room. In this connection, bearing in mind that every one must anticipate their requirements for drawings as much as possible, the Drawing Boy should 'phone in to the Drafting Room as early as possible asking for certain drawings giving the time that he will want them. The Drafting Room Boy is to make a note of this number and lay the drawings out ready, and then notify the Shop Boy promptly. The Shop Boy will then go to the Drafting Room, get the drawings and return to the Shop with a minimum amount of delay. These same instructions must apply for the issuing of drawings to those other than the Drawing Boys. If a *Foreman* or a *Gang Boss* is in need of a drawing and does not have a Drawing Boy available he must 'phone in his requirements in advance and if he cannot do this, then send a *Special Messenger* to the Drafting Room for the drawings in question.

11. The necessity for anticipating requirements is just as important and essential in regard to this particular part of the work as to any other. Observance of these instructions will save a great deal of time and commotion. The Shop Boys are not to linger on the way to, or from, the Drawing Room or Tool Room, neither is the Drawing Room Boy to linger on his way to the Shops nor in them.

XXXII

Duties of the Night Watchman

1. The *duties* and *time schedule* of the night watchman will be as follows:

2. He will start each round at Key 1 in the Engine Room, the first trip starting at 6 P.M.; one trip will be made every hour afterward all night until and including the trip which starts at 5 A.M., which will be the last.

3. The clock will be rung from the different stations in the following order:

Key 1. Engine Room.
Key 12. Forge Shop.
Key 6. Assembly Room.
Key 10. Clock west end of machine shop.

NOTE. After ringing Key 10, heating engine over head must be inspected as to proper lubrication, etc., before ringing Key 8.

Key 8. N. E. Cor. Machine Shop.
Key 3. Carpenter Shop.
Key 5. Pattern Store.
Key 9. Drafting Room.
Key 11. Office Attic.
Key 2. Office Basement.
Key 4. Counting Room, then return to boiler room.

NOTE. The above route covered properly requires fourteen minutes, not less.

4. The watchman is required to exercise due vigilance on each trip, take the time specified to make each trip and to note carefully his surroundings as he passes through the works so as to detect and take measures to rectify anything unusual or suspicious. This is especially necessary when passing through or by the wood working shops, offices and boiler room, which he does every fifteen minutes.

5. The watchman is to thoroughly sweep and dust,

including wiping off all the standing finish and furniture in each of the following offices and rooms:

A. Office Attic and stairs including the President's room at the foot of the stairs.
B. Drafting room and clothes closet.
C. Vice-President's office.
D. Secretary's office.
E. Counting room.

6. By referring to Paragraph 7, it will be seen that there is thirty minutes available each hour for the above work, thus allowing ample time to clean one office or room each hour for five hours; the watchman is allowed to have two incandescent lamps lighted while he is cleaning such offices, if one is not sufficient. The two lamps mentioned must not be used for more than a total of five hours a night.

7. Time schedule is as follows:

Start ringing clock from Key 1 as in Paragraph 2 at 6 P.M. and proceed as directed in Paragraph 3, taking fourteen minutes, and returning to boiler room at 6.15. Period from 6.15 to 6.20 to be spent in boiler and engine room, period 6.20 to 6.35 cleaning in office; period 6.35 to 6.40 in boiler and engine room. Period 6.40 to 6.55 to be used to complete cleaning office room started at 6.20. Period 6.55 to 7.00 in boiler and engine room. Repeat the above every hour except that the last office should be cleaned not later than 11 P.M. The following time during the night corresponding to the time devoted in the earlier hours in cleaning offices is to be utilized for the Company's best interests as circumstances may require.

8. In cold weather when the heating system is operating, the fires must be cleaned and put in proper order between 4 A.M. and 5 A.M., at which time the day engineman comes on duty.

9. The watchman's hours are from 6 P.M. to 5.30 A.M. daily.

10. The watchman is under no circumstances (except as directed in Paragraph 13) to leave the Company's premises during his hours on duty or to smoke on the premises, and any violation of this rule will be considered sufficient reason for discharge without notice.

11. The telephones are not to be used except on company business or in case of death or illness; this applies to both incoming and outgoing calls.

12. Additional Trips, Night Watchman. In addition to the duties specified above the night watchman will make the following trips:

13. The 8 P.M., 11 P.M., 2 A.M. rounds are to include a trip to the New Pattern Storage on Elm Street, just north of the main plant. The watchman is to enter the building and inspect the interior of both floors, and look carefully for evidences of fire, especially for sparks from R. R. Engines. These three trips are the only exceptions permitting the watchman to leave the premises of the main plant during his hours of duty.

XXXIII

Janitor's Instructions

1. Commencing February 1st, 1911, one janitor will be employed with duties as outlined below.

2. In making up these daily routine duties, opposite each is noted the time in minutes, in which the various sub-operations should be accomplished. All these items are based on actual stop-watch observations and the sub-operation totals are transposed into hours and hundredths, which represents the time allowed for doing each operation.

3. These times are based on a man working at his best *normal* speed, and operations are listed in the order in which we wish them performed.

	Minutes.	Hours.	Bonus.
4. Morning Work. At seven o'clock leave the locker room, go to the office and collect five cuspidors, return to the locker room, clean cuspidors thoroughly, get water pail, broom and mop, lock locker room and assembly room doors, return to office and distribute cuspidors to their places	9	.15	$.0075
5. Clean four office lavoirs and the President's private wash room. Polish name plate and hand rails outside front office and polish eleven name plates on doors opening into office lobby, lavoirs, and return to locker room	36	.60	.030
6. Remove ashes (on an average of five loads) and return to locker room	36	.60	.030
7. Clean wash troughs in locker room and thoroughly mop up the floor	48	.80	.040
8. Go to die shop closets with broom, mop and hot water, and thoroughly sweep and scrub same, and clean hand basin at the foreman's desk and return to the locker room	9	.15	.0075
9. Go to the press shop closets with broom, mop and hot water, and thoroughly sweep and scrub them and clean wash basin in corner; then go to the store room taking broom, mop and empty pail	9	.15	.0075
10. Thoroughly sweep store room, clean wash basin and cuspidors, and go to Superintendent's office	24	.40	.020
11. Thoroughly sweep the Superintendent's office, dust the furniture and clean out wash basin; then return to locker room taking the Superintendent's cuspidor along. Thoroughly clean the same, leave pail and mop in its proper place, take broom along and return the Superintendent's cuspidor and continue to the tool room	9	.15	.0075
Rest period, if wanted	12	.20	.010
12. Thoroughly sweep both departments of the tool room, remove chips, clean the hand basin in the corner, empty cuspidors, then go to Die Shop	24	.40	.020
13. Thoroughly sweep die shop, remove chips, empty cuspidors and go to locker room	9	.15	.0075
14. Go to boiler room closet with broom, mop and hot water, thoroughly sweep and scrub the same and return to locker room	9	.15	.0075

	Minutes.	Hours.	Bonus.
15. Prepare fresh water, go to pattern shop closet, thoroughly sweep and scrub same and return to locker room; clean and put away mop and bucket	15	.25	.0125
16. Prepare hot water in locker room, unlock doors, etc., previous to quitting whistle	12	.20	.010
	300	5.00	$.2500
17. Afternoon Work; Monday to Friday Inclusive. Empty wash trough in locker room, thoroughly sweep and scrub same including floor	15	.25	.0125
18. Remove ashes (based on an average of five loads each afternoon)	36	.60	.03
19. Sweep the north bay of the machine shop between the east wall and store room, and remove chips	48	.80	.04
20. Sweep main press shop including erecting floor and part west of the dead line, and remove chips; includes twelve minutes' rest period	189	3.15	.1575
21. Prepare water in the locker room prior to the quitting whistle at 6 p.m.	12	.20	.01
	300	5.00	$.2500
22. Saturday Afternoon Duties: Starting at 12.5. Empty wash trough in locker room, thoroughly sweep and scrub same, including floor	30	.5	.025
23. Remove ashes, based on an average of five loads	36	.6	.03
24. Sweep north bay of machine shop between the east wall and the store room, clean cuspidors and remove chips	42	.7	.035
25. Sweep main press shop including erecting floor and part west of the " dead line," clean cuspidors and removec hips; includes twelve minutes' rest period	114	1.9	.095
26. Repaint " dead line "	18	.3	.015
Quit at 4.30.	240	4.0	$.200

27. It is not part of the janitor's duty in connection with the above to move material, tools and fixtures as they must be kept in proper order at all times by the foremen and gang bosses in charge. Foremen and gang bosses

will furthermore see that the men at the machines keep their floors clean, and when brushing chips from machines to floor, they must keep them always in a neat pile. The object of this is to maintain the neat appearance of the shop as a whole, and to assist the janitor in the accomplishment of the above schedule.

28. The Superintendent will weekly sign the janitor's bonus slip, based on 5 cents per hour bonus if *all* the above work is done *daily* and *satisfactorily*. When one or more items are not properly done, then bonus for those items will be omitted.

XXXIV

Duties of Crane Boss

1. With practically all machines running in the main bay of Press Shop and a gang of 15 or more men on the Erecting Floor, a Crane Boss should be employed with duties as follows:

2. The Crane Boss has absolute charge of the cranes, and the crane men are under his orders as far as their order of work is concerned.

3. Foremen, Gang Bosses or workmen are not to call for cranes except through the Crane Boss. The Crane Boss will serve each call as far as possible in the order in which he receives it, other things being equal.

4. Preference will be given on general principles to machine service as the expense of waiting is greater for this class of work than any other.

Second in importance will be the Erecting Floor calls.

Third importance will be given to Clearing Department calls.

Fourth importance will be the Material Moving Boss.

Fifth importance will be the unloading of incoming material and shipping.

5. Judgment must be used by the Crane Boss in considering the above classification. He must consider the

length of time a crane will be tied up on each lift and must deviate from the above general order of the preference, so as to give the quickest service possible. In connection with this item there must also be considered the number of men kept waiting. It is obviously expensive to delay several high priced men in a gang on the erecting floor for the sake of serving a machine first. This same rule, however, does not apply to a gang in the cleaning department where the rate of wages is only about one-half that of the machine and floor hands, to say nothing of equipment charges.

6. The Crane Boss must keep in close touch with all work in the main bay of the Press Shop and regulate and anticipate the requirements for crane service.

7. For small parts that can be handled by truck expeditiously he will refuse crane service.

8. Workman and Bosses must give the Crane Boss as much notice as possible so he can serve them with a minimum of delay.

9. Crane men must not be allowed to traverse the crane or truck unless absolutely necessary. This also applies to the raising and lowering of the hook. Maintain only sufficient head room from the floor.

10. When handling work up and down or across the shop, try to avoid passing over the heads of men below as much as possible.

11. The Crane Boss must be "on the job" on the floor at all times and follow the cranes sufficiently to give prompt attention to both the crane men and those they are serving.

12. The Crane Boss is *not* to sling or handle any work; neither is he to give any directions to the crane men as to the moving or handling of a piece.

XXXV

Instructions Pertaining to General Orders

FORM FAP31s. See Plate IV.

1. Examination of this form will make evident the method of filling it in as indicated by the printed headings. It is extremely important that none of the data called for on the printed form be omitted.

2. The General Orders are made out originally by the Chief Clerk. Three copies are typewritten at the same time, the original remaining in the Counting Room active file, the first carbon going to the drawing room and the second carbon to the Production Clerk.

3. It is the Chief Clerk's duty to see that he gets sufficient information either from the customer's order, the Engineering Department, or elsewhere to make the wording of the order simple, yet in sufficient detail to cover all information, and to make a clear specification of what is required.

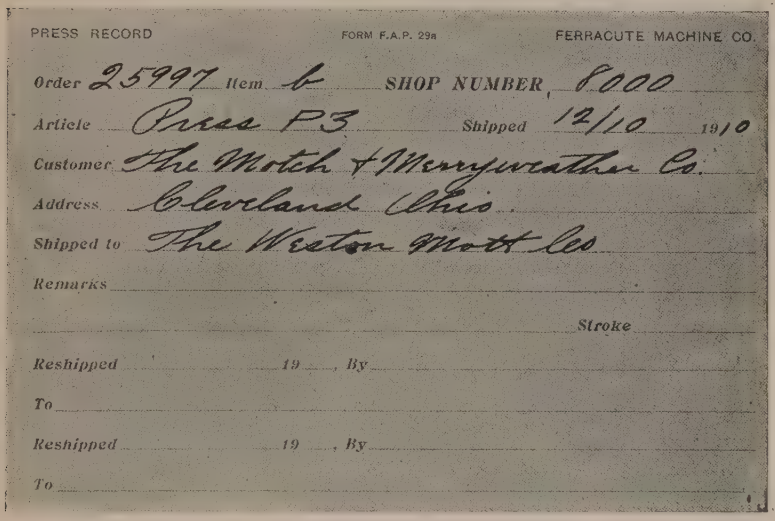
4. Great care should be taken to get clear legible copies both on the original and carbons, using plenty of fresh carbon paper, and so spacing the written matter as to avoid congestion.

5. As this order form provides for the use of as many sheets as is necessary to clearly specify what is wanted, the spacing should not be close unless absolutely necessary. Where the order consists of a number of items, they should be so distributed as to have each item complete on the sheet on which it starts. Another advantage in having open spacing between lines is that additions or alterations to the order (always made in red) may be interlined without crowding.

6. The original copy which remains on file in the Counting Room is to be an exact duplicate of each of the other two, except that the price and terms are to appear only on the Counting Room copy.

7. The engineering department will be responsible for noting in the column "Drawing" the required drawing, sketch or other reference marks. These are to be placed on both their copy and the Counting Room copy.

8. The Planning Department will be responsible for noting on their copy and the counting room copy, in the column provided, the job numbers showing on what job


PRESS RECORD FORM F.A.P. 29a FERRACUTE MACHINE CO.

Order 25997 Item 6 SHOP NUMBER 8000

Article Press P3 Shipped 12/10 1910

Customer The Motch & Merryweather Co.

Address Cleveland Ohio.

Shipped to The Weston Motch Co

Remarks

Stroke

Reshipped 19 , By

To

Reshipped 19 , By

To

FIG. 46.—Press Record card. One of these cards is filled out and filed for every machine shipped.

the various items are to be built, so that the cost sheets can be directly referred to.

9. The Chief Clerk will be responsible for noting on the Counting Room copy the shipping dates for the various items, as well as the shop numbers if the order calls for Presses or Machines. See Fig. 46.

10. A vertical file is provided in the vault C with a capacity of one or two years' general orders, and it is one of the Chief Clerk's duties to see that these orders are arranged numerically and kept in proper condition in this file. Before orders are filed he must be sure that all

the necessary notations have been made as above explained, consisting of:

A. Reference to the job number on which the work was done, so that cost can readily be referred to.

B. Drawing room reference in " Drawing " column.

C. Date shipped.

D. Shop number when necessary.

11. The Drafting Room copy need not be permanently kept and it is left to the direction of the Assistant Engineer as to when to destroy those for orders shipped.

12. The copy kept on file in the Planning Department will probably be permanent as a reference for that department. The Counting Room copy, in the vault C in the office, should have filled in the above items complete, so in event of loss by fire, all information will be found on these original copies.

13. When the vertical file referred to in the Counting Room vault is full, the older orders should be transferred to the " transfer files " in the basement, vault B. This file is also to be in charge of the Chief Clerk.

14. All orders for which delivery has been positively guaranteed or which are subject to cancellation if not shipped on the date promised, or others which for important reasons in the judgment of the Sales Manager must not be delayed, must bear a red seal. This seal is to be attached to each copy of the general order, beside the date for completion. This paragraph does not contemplate the promiscuous use of this seal which must be used with due judgment and caution. The regular routine methods handle all orders on an average of within less than 10 per cent variation over the promised date.

15. It is important at the time the general order is originated to have it divided into a requisite number of items, so that their individual costs can be intelligently analyzed. This is extremely important in large orders, especially those having quite a variety of parts or machines. All orders for work other than standard should have an

item covering the testing or experimenting after the completion or building proper, and in some cases, several or more items for experimenting might be desirable.

16. The initial responsibility for the marking of the "date to be completed" lies with the chief clerk. This date must be put on the order at the time it is issued by the chief clerk or as soon after as the date can be obtained *by him* from the Superintendent or planning room. The chief clerk must follow up all orders issued without the date mentioned for shipment and see that it is marked on the order. "Rush Rush," "Hurry," "at Once," and similar phrases *must be omitted;* they mean absolutely nothing and are but a make-shift to shift responsibility.

This completion date must never be originated by the chief clerk; the superintendent is responsible for this information. The correspondence will often have this date specified based on the superintendent's promise for delivery prior to the booking of the order.

17. The Planning Department subdivision of an order for cost, generally speaking, should be based on the various items as noted on the original order. The Production Clerk is cautioned to inspect each order as it is received in the Planning Department, to be sure that it is sufficiently itemized to enable him to get a cost which can be readily analyzed.

18. Presses or other machines built to be shipped on any specific order are always to be built on "M" jobs. This also might be the case with special attachments, etc., on which an individual cost is desirable. Repairs, miscellaneous orders, dies, etc., are ordinarily built chargeable to the original order and item.

19. Stock jobs will invariably be built on "L" numbers and in no instance will more than one kind of article be built on any one "L" job.

20. Commencing with the use of the Schedule Cost sheet Form FAP49a (see Plates VII and VIII) jobs being charged direct to order and item will be subdivided as

much as possible to next-work orders, so that on the completion of a job, the itemized cost and individual operation, items, etc., may be obtained at a glance from the completed cost sheet.

21. For the information and guidance of the Engineering and Drafting Room, it may sometimes be desirable to subdivide a cost which ordinarily would not be necessary or desirable. In combining this possibility with the requirements of the Manufacturing and Business Departments, it is desirable that the Engineering and Drafting Rooms, Counting Room and Planning Department work in conjunction to get the required or most desirable cost subdivision.

XXXVI

Old, Broken or Replaced Parts Returned

1. On receipt of old, broken or otherwise defective parts, the Receiving Clerk is to attach Repair Tag, Form FAP32s (see Fig. 11, Chapter IV) to such part or parts, marking on such tag from whom received and the date.

2. Parts that can readily be handled by one person and which are not too cumbersome are to go at once to the Chief Clerk, who issues the General Orders. He will note on repair tag the Order and Item to which the part in question applies, and then pass the tagged part (after he is through with it) along to the Engineering Department, who, when they are through, will pass it on to the Planning Department.

3. The Planning Department in issuing orders to the shops in connection with repairs, must in all cases, where parts are returned, refer to them on all orders in addition to the drawing or sketch reference. They must see that the original tag remains on the piece, which must accompany the new work through the Shops to the men and machines.

4. The Chief Clerk must see that each tag has marked

on it the proper Order and Item before it leaves his Department, or if the piece is too large to send to the offices, he will number the tag on the piece in the Shops.

5. The Planning Department is to see that the tag bears all Work Numbers so that each Gang Boss can check his work with his order and the old part, without danger of working to the wrong piece.

6. The Repaired or Replaced parts previous to shipping will finally be checked by the Inspector to the Drawing, as well as with the part returned and with the Work or Department Order on which it was made. It must not be shipped without his approval.

7. A place will be provided to temporarily keep old or returned parts for a reasonable length of time (preferably in an inconspicuous place) after which they will be scrapped. The job on which the replace parts were made must be credited with the scrap value of the old pieces.

XXXVII

Purchase Orders

1. The following will explain the method of handling Requisitions on their arrival in the Purchasing Department and the issuing of Purchase Orders.

2. All Requisitions, Form FAP13, Fig. 2, Chapter II, must be duly scheduled and checked against the Stores Cards in the Planning Department, after which they are to be passed to the Organizing Engineer or Superintendent, for approval before going to the Purchasing Department.

3. On receipt by the Purchasing Agent of a Requisition properly filled out as above, he will as soon as possible issue the necessary Purchase Order, Form FAP14–15–16, Plate I, and fill in on the bottom of the Requisition the name of the party material was purchased of, Purchase Order No., date, and affix his signature. The Requisition will then be returned at once to the Planning Department.

4. The Purchase Order Forms in triplicate are distributed as follows:

The White Form FAP14a is the original and goes to the party who is to furnish the articles called for.

5. The Yellow Form, FAP15a is the duplicate and is an exact copy of the original. It is to remain on the Purchasing Agent's file until the Purchase Order is filled for reference and to check invoices when received for correct price, amount and specification.

6. The Blue Copy, Form FAP16a is the triplicate and goes to the Receiving Clerk by way of the Planning Department. It is also a true copy of the Purchase Order proper but does not show prices or terms, and *does* show where material is to be delivered. It has the Receiving Clerk's signature.

7. Purchase orders need not be made out for small local purposes of less than fifty cents, but it is necessary that the Requisitions all follow the same course. Those articles, however, that are petty cash purchases will have the Requisition so marked and after being closed off on the Schedule, the Requisition will be returned to the Purchasing Department. The object of this is to use the Requisition as a check against the Petty Cash Charges, or in cases where the charges, although Petty Cash Purchases, are settled for at the end of each month, as per the " Pass Book " supplied the vendor by the Company for this purpose.

8. All Requisitions will have the " date wanted " as remote as practicable. They will be systematically followed by means of the Purchase Order Schedule, thus keeping the Purchasing Agent advised of the condition of his Purchases.

9. It is of course necessary that material be on hand when wanted. With the Stores Department and Engineering Department in smooth working order there should be no trouble about this, even allowing sufficient time for the Purchasing Agent to look up prices so that he may buy to advantage.

XXXVIII

Patterns, and Casting Purchase Orders

1. As soon as the material list in the Planning Department is checked with the stores account, all castings are to be ordered; the purchase orders are to be made out in triplicate (see Plate III), the white copy FAP19a and blue copy FAP21a remaining in the Planning Department while the yellow copy FAP20a is sent to the pattern foreman. A file is provided for him to keep them on if it is necessary for him to hold them.

2. The drawing number for the article called for by each casting purchase order is to be plainly marked on the face of the original and carried through to the others with carbon paper so as to give the pattern maker the drawing reference so he can check the pattern referred to. As soon as the yellow order is received by him, the pattern is to be immediately located, and checked with the drawing. The symbol must be on as called for by the order. As soon as the patterns are loaded or are on the way to the foundry, the pattern foreman is to sign the yellow FAP20a, date it in the lower left-hand corner, and immediately pass same to the Planning Department. The Planning Department will then note on the schedule PF opposite the proper date, showing that the pattern has gone to the foundry. The Production Clerk will immediately issue the original Form FAP19a (which he has been holding) to the foundry, and also send the blue form FAP21a showing the destination of the material, to the Receiving Clerk. The yellow Form FAP20a goes on to the Planning Department file.

3. When casting purchase orders are being originated by the Planning Department, the dates on which the castings are wanted at the shop will be carefully considered and the pattern maker must watch these dates to see that the patterns are gotten away in time to enable the foundry to make and deliver the castings by the time wanted. When

the yellow copy is returned properly signed and dated by the pattern maker to the Planning Department, the schedule clerk must stamp on the face of it the date he receives and schedules it.

4. In referring to the schedule above, the notation on the casting purchase schedule of when the pattern went to the foundry is meant, as of course, these casting purchase orders are immediately scheduled when made out (OR), before the yellow slip goes to the pattern shop. When it returns the symbol PF (Pattern to foundry), goes on the casting purchase schedule under the proper purchase numbers and opposite the date on which the pattern went to the foundry, so that a glance at the schedule shows what delay, if any, was caused by the pattern shop in getting out the pattern.

XXXIX

Brief Description of Each Form Giving Figure or Plate, and Page Reference

Form FAP2b. Next Work Order.
Size 3″ by 5″. Yellow and Pink Paper.
Fig. 9. Page 62.

Issued by the Route Clerk. Forms FAP3b, 4b and 5b are ruled the same but the paper and color combinations are different as explained in Chapter IV.

Form FAP6a. Material Card.
Size 3″ by 5″. Low-grade white card.
Fig. 19. Page 103.

Issued by a limited number of authorized persons and is used for credits and debits to stores or jobs for work in process. See Chapter V.

Form FAP7a. Stores Card.
Size 5″ by 8″. High-grade buff card.
Fig, 17. Page 99.

Created in the Planning Department and forms a permanent record of rough, semi-finished and finished

parts in stock, so maintaining the stores ledger or perpetual inventory. See Chapter V.

Form FAP9a. Move Material.

Size 3″ by 5″. Cheap white paper.

Fig. 12. Page 79

Issued by the Planning Department or Material Boss for the moving of material not automatically provided for on the next work order.

Form FAP10b. Schedule.

Size 12″ by 18″. Cheap white paper.

Plate II. Back of book.

A graphical record used to keep track of and to follow up Orders, Jobs, Purchases, Casting Purchase Orders, etc. (This form was first devised by Mr. H. L. Gantt to whom the author is indebted for its use). See Chapter III.

Form FAP11a. Material List.

Size 9″ by 12″. Thin high-grade white Bond paper.

Fig. 5. Page 35.

Issued by the drawing room as duplicate blueprints. One list is furnished with every order requiring more than two or three pieces. The original or negative is thin high-grade white Bond paper. See Chapter II.

Form FAP12a. Department Order.

Size 6″ by 9″. Medium-grade white Bond paper.

Fig. 47. Page 316.

Issued by Route Clerk and used for miscellaneous and jobbing work which is not routed in detail. The exceptions in which this form is used are referred to in Chapter III.

Form FAP13a. Requisition.

Size 6″ by 9″. Medium-grade white Bond paper.

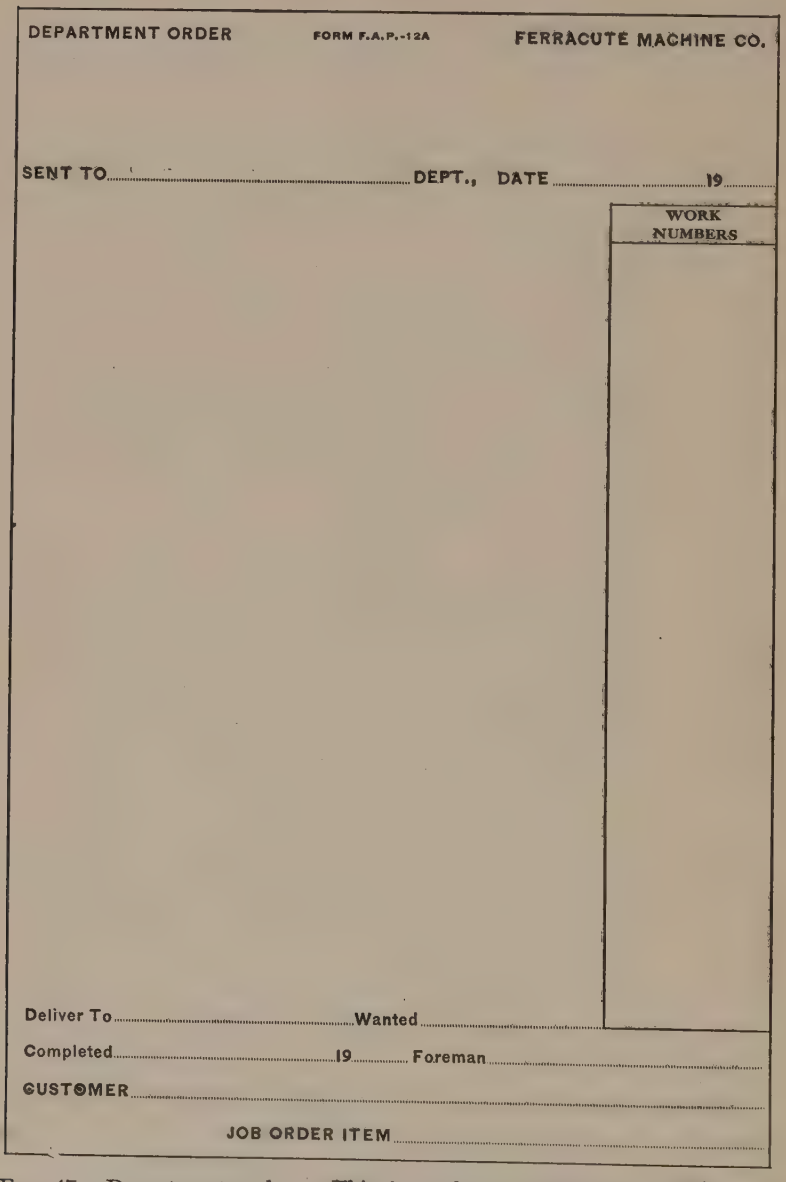
Fig. 2. Page 14.

Issued chiefly by the Production Clerk for requisites other then gray iron castings. See Chapter III.

Form FAP14a, 15a, 16a. Purchase Orders.

Size 8″ by 10″. Medium-grade Bond paper.

Plate I. Back of book.


DEPARTMENT ORDER FORM F.A.P.-12A FERRACUTE MACHINE CO.

SENT TO..... DEPT., DATE..... 19.....

WORK NUMBERS

Deliver To..... Wanted.....

Completed..... 19..... Foreman.....

CUSTOMER.....

JOB ORDER ITEM.....

FIG. 47.—Department order. This is used for all work on which each specific operation is not controlled by a work order. Fig.9, page 62.

Issued by the Purchasing Agent in triplicate. The white or original copy (FAP14a) goes to the vendor, the yellow duplicate (FAP15a) remains on the Purchasing Agent's file and the blue triplicate (FAP16a) goes to the Receiving Clerk in the Production Department. See Chapter II.

Form FAP17c. Job Time Card.

Size 5″ by 8″. Manila card.

Fig. 20. Page 107.

Issued by Time Boy in the Planning Department who fills in the time check coupon at top of the card; the remaining job coupons on the card are filled out by the Gang boss or foreman. See Chapter V.

Form FAP19b, 20b, 21b. Casting Purchase Order.

Size 4½″ by 6″. Medium-grade Bond paper.

Plate III. Back of book.

Issued by the Production Clerk, acting as assistant to the Purchasing Agent. The original white copy (FAP19b) goes to the foundry, the yellow duplicate (FAP20b) goes first to the Pattern Foreman, as his order for pattern, to be later returned by him for the Planning Department file, the blue triplicate (FAP21b) goes to the Receiving Clerk. See Chapter II.

Form FAP25a. Drawing Index by Number.

Size 3″ by 5″. High-grade salmon-colored card.

Fig. 39. Page 223.

Created in the drawing room for the drawing index files. It is arranged in the files numerically by the drawing number. See Appendix, VIII.

Form FAP26a. Drawing Index by Subject.

Size 3″ by 5″. High-grade buff-colored card.

Fig. 40. Page 224.

Created in the drawing room for the drawing index files. It is arranged in the files by subject and positioned by symbol. See Appendix, VIII.

Form FAP27a. Drawing Index by Customer.

Size 3″ by 5″. High-grade green-colored card.

Fig. 41. Page 224.

Created in the drawing room for the drawing index files. It is arranged in the files alphabetically by customer's name and positioned by symbol. See Appendix, VIII.

Form FAP28a. Casting Receipt.

Size $4\frac{1}{2}''$ by $6''$. Medium-grade pink Bond paper.

Fig. 45. Page 276.

Issued by the foundry and covers by class group each shipment of castings.

Form FAP29a. Press Record.

Size $4\frac{1}{2}''$ by $6''$. High-grade buff-colored card.

Fig. 46. Page 307.

Created in the counting room to form a permanent office record and index of the shipment of each machine, principally presses. See Appendix, XXXV.

Form FAP30a. Inventory Sheet.

Size $12''$ by $18''$. Good white Bond paper.

Plate IX. Back of book.

For use by certain authorized persons in connection with taking an actual "count and weigh" inventory. This is a very convenient form especially when taking the extremely accurate inventory necessary before starting the perpetual inventory; see Form FAP7a. Chapter V, page 99.

Form FAP31b. General Order.

Size $8''$ by $10''$. High-grade white Bond paper.

Plate IV. Back of book.

Issued by the Chief Clerk in the counting room and only made out with the approval of an officer of the company. See Chapter II.

Form FAP32a. Repair Tag.

Size $2\frac{3}{8}''$ by $4\frac{7}{8}''$. Heavy Manila Card.

Fig. 11. Page 69.

Issued by the Planning Department and is attached to parts returned by customers for alterations, repairs or replacement. See Chapter IV.

Form FAP33b. Symbol Tag.

Size $1\frac{7}{8}''$ by $3\frac{7}{8}''$. Heavy Manila Card.

Fig. 10. Page 68.

Issued by the Planning Department and is attached to each piece in process. See Chapter IV.

FORM FAP35a. Instruction Card.

Size 9″ by 12″. High-grade white Bond paper.

Fig. 30. Page 158.

Issued by the Planning Department and forms a final standard for each operation or job. See Chapter VII.

FORM FAP40a. Visitors' Permit.

Size 3″ by 5″. Medium white Bond paper.

Fig. 38. Page 210.

Issued by an officer of the company. See Shop Rules, Appendix, IV.

FORM FAP43a. Sketch Index by Subject.

Size 3″ by 5″. Medium buff-colored card.

Fig. 42. Page 225.

Created in the drawing room for the sketch index file. Arranged in the file by subject and positioned by symbol. See Appendix, VIII.

FORM FAP44a. Sketch Index by Number.

Size 3″ by 5″. Medium salmon-colored card.

Fig. 43. Page 225.

Created in the drawing room for the sketch index files. Arranged in the file by sketch number. See Appendix, VIII.

FORM FAP46a. Bonus Pay Slip.

Size 3″ by 5″. Medium blue Bond paper.

Fig. 44. Page 258.

Issued by the Planning Department in duplicate. One copy goes into the workman's bonus pay envelope and the other is filed in the Planning Department after the correct entries have been recorded on the schedule cost sheet. See Appendix, XX.

FORM FAP47a. Inspector's Condemnation Report.

Size 3″ by 5″. Medium white Bond paper.

Fig. 8. Page 61.

Issued by the Inspector upon condemning all or part of any piece or job. See Chapter III.

FORM FAP48a. Alteration Memorandum.
Size 3″ by 5″. Medium white Bond paper.
Fig. 48. Page 320.
Issued by the head of any department and may apply to an alteration in any record or piece.
FORM FAP49½a. Schedule Cost Sheet.
Size 12″ by 24″. High-grade white Bond paper.

ALTERATION MEMO. FORM F. A. P. 48-E FERRACUTE MCH. CO.

Please Note the Following Alterations to P5 Frame pattern, drawing 10184. Shaft hole not in line with bed. Also correct gear stud bosses, inside and outside faces.

FROM H. Camelin to P. Meyers, 7/19 1911, 1. ~~A. M.~~ P. M.
FROM P. Meyers to R. Elmer, 7/19 1911, 2. A. M. P. M.
FROM ..... to ....., ... / ... 19 ..., A. M. P. M.

FIG. 48.—Alteration memorandum used by all department heads to report any alteration.

Plate VII and VIII. Back of book.
Created in the Planning Department and forms a combined route and cost sheet. See Chapter V.
FORM FAP51a. Solicitation Record (Mailing List).
Size 3″ by 5″. Medium white card.
Fig. 3. Page 18.
Created in the Sales Department and is used to follow up prospective customers, inquiries, etc. It also forms an index to the salesman's report file. See Chapter II.

SIX YEARS AFTER

(February, 1917)

Six years have elapsed since the publication, in serial form, of the first eight chapters of this book. The following data are appended to enable the reader to judge for himself how the methods described in the foregoing pages have stood the test of time.

In the June, 1911, issue of *Current Literature*, there appeared an article entitled "An Indictment of the New Science of Management." That article discussed the work of Dr. F. W. Taylor and also reviewed to some extent the first part of this book, then appearing in serial form in the *Industrial Engineering Magazine*. It referred at length to *The Railway Age Gazette* as follows: "This daily has studied the subject in a series of articles based upon what it deems the 'mistakes of the efficiency men.'" *Current Literature* adds "much of what they have said (*Gazette*), it reminds us, has been allowed to go unanswered." May this chapter materially help the *vindication* of the "New Science of Management."

The author, in a lecture on Shop Management before the New England Railroad Club on December 13, 1904, at Boston, Mass., opened his remarks by making a prophecy. "I shall endeavor to give you the outline of a system of shop management *which I believe is slowly but surely becoming universal in this country*." How is that prophecy working out? Dozens of representative firms are now operating under methods based upon the principles of the science of management. Every up-to-date firm in the United States is now more or less familiar with the science of management. Firms in England, France, Germany, Norway and Japan have, to the author's personal knowledge, interested themselves favorably in the subject. The Boards of Commerce of some of our largest cities are conducting systematic campaigns to stimulate the interest of their

members toward a general adoption of methods founded upon the science of management. The next few years will show an unprecedented growth of efficiency throughout all parts of the country.

What can be more interesting and valuable at this stage of the history of the science of management than an investigation of how the methods described in the foregoing pages of this book have borne the test of time and the demands for intensive production. The Ferracute Machine Co. has now been operating in part under the author's methods for *nine years*, and wholly under his methods for *six years*. It has been *five years* since he has taken any active charge of, or control over, the operation of that plant. What has been the result? Has the organization been self-sustaining during that period? Has it been able to meet the demands of a greatly increased volume of business? Can it withstand the "rack" of war? Has the management been satisfied to leave the methods alone and realize on the organization investment to the full, feeling satisfied that they have real management and not "*red tape*"?

Such questions can *only* be answered by the officials of the company employing its methods. Permission has been granted to the author to publish letters received by him from the President, Secretary-Treasurer, Director and Engineer, and the Superintendent. These letters are reproduced below. Such letters speak for themselves, coming, as they do, from the very officials who arranged with the author in early 1907 to install his methods complete.

BRIDGETON, N. J., U. S. A.,
November 30, 1915.

MY DEAR MR. PARKHURST:

It may interest you to know that I frequently have inquiries from friends in manufacturing businesses of various kinds regarding our system of scientific management, which you so ably installed for us a few years ago, and that, as a matter of course, I have referred such inquirers to your book, "Applied Methods of Scientific Management."

Our "Planning Room" has proved of much interest to the pilgrims whom we invite to inspect it.

I regret to say that you do not come around to see us nowadays as often as it would give me personal pleasure to have you do, but I can assure you that we do not in any way regret the work you did for us, which is a lasting one, embodying a system which seems so well organized, that we do not have occasion to alter it, except perhaps in trifling matters, as new conditions arise.

We consider an organization of this kind as an asset of positive value, although (in common with that companion asset called "good-will") it is not exactly a commercial asset which we can put in our inventory. Nevertheless, we know that both of these somewhat intangible realities are a part of the actual value of any business which enjoys their presence.

We have found during the last three or four years, since you left us, that we are well repaid for the considerable initial expense of the "organization" in increased profits on most of our goods, especially those of a standardized character. Furthermore, it has given us a trained corps of experts who attend to routine matters, which tends to much relieve the work of the executives of a business so various in its character, and making so many different products, as is the case in our Works.

With kind regards, and a hope that you will look in on us as occasion occurs, I am,

Faithfully yours,
(Signed) Oberlin Smith,
President Ferracute Machine Co.

Mr. Frederick A. Parkhurst.

Bridgeton, N. J., U. S. A.,
December 11, 1915.

Mr. Frederick A. Parkhurst,
Buffalo, New York.

My Dear Mr. Parkhurst:

Referring to the applied methods of scientific management installed by you in our Plant several years ago, and which is so well explained in your book "Applied Methods of Scientific Management," I have found it a pleasure from the standpoint of purchasing materials, taking care of them in connection with our Stores Ledger, and also from the standpoint of selling our Presses, it having worked out much better than we could have ever expected. We are now able to quickly name an almost exact delivery in quoting on Presses, and a delivery that we can meet, instead of guessing at a delivery, and oftentimes making the guess entirely too early, thereby making trouble for the customer and ourselves in not shipping on time. By this system, as you know, our work is so planned out ahead, and with reasonable despatch, that we can

quickly come to a definite conclusion regarding a shipping date, and although this shipping date ofttimes is not as early as we would like to name, we know that it is one that we can depend upon. Furthermore, while our customers often complain because we cannot name quick enough delivery, in all cases (particularly that of our old customers) they know that they can depend upon the deliveries that we do name, and oftentimes they will place their orders with us for a longer delivery than they will with one of our competitors for a promised shorter delivery, knowing that with our system they can almost absolutely depend upon the delivery that we name.

During the past few years we have made many friends of our customers on account of using system in the manner above named and getting the results specified therefrom.

During exceedingly busy times we know that we would not have been able to have taken care of any more than 60% of the work that we did, and are, taking care of without this system. Practically the only troubles that we have had in recent years (and this has been in but few cases) has been in not meeting the delivery dates where we have had to depend upon promises of outside parties from whom we have purchased materials to be used in the manufacture of our products. We also are able to get accurate costs quickly and systematically, which is a great help, and really should be considered by all Manufacturing Plants a necessity.

Therefore, in summing up, it is certainly a pleasure to work in connection with the System, as installed by you, and we are always ready to show it to our friends.

Yours very truly,

(Signed) ENOS PAULLIN,

Secretary FERRACUTE MACHINE COMPANY.

H.M.S.

BRIDGETON, N. J., U. S. A., December 28, 1915.

MY DEAR MR. PARKHURST:

I have been thinking for some time I would let you know my views regarding the system in use at our Plant for several years, and which is so ably defined in your book "Applied Methods of Scientific Management."

I state without hesitation that the system in all of its details, has been working satisfactorily since its installation. It has been a marvel to me that such a system could be applied to our varied product without experimenting, but it has not been changed from that which you originally installed and it has been accomplished by our own employees.

When you came to us, our Shop was so congested we were at our wits' end to plan our work in a manner that would enable us to make shipments anywhere near our promised dates, but when your system

was in working order the problem was solved. We are now able to attain a delivery efficiency of over 100 per cent. This, of course, is only possible where certain promises of deliveries have been anticipated, which we have frequently done. As you will notice, we are publishing the following on our Letter Heads, "Our system of SCIENTIFIC MANAGEMENT since January 1st, 1912, has given us an EFFICIENCY in "DELIVERIES" of 103 PER CENT. Thus the average time for all shipments has been SHORTER THAN PROMISED."

We now handle from fifty to seventy-five per cent more business than we could have hoped to do without our present organization; this fact has been particularly in evidence during the extreme rush of this year's business.

In our Engineering Department the work of estimating, etc., is greatly facilitated, and we now state facts accurately, whereas formerly there was a good deal of guessing.

By using drawings containing individual pieces, properly figured for clearances, etc., and Material Lists giving quantity and name of article, material, piece symbol and drawing numbers, much time has been saved.

During my frequent visits to concerns who manufacture numerous variety of articles, I have repeatedly been questioned as to the feasibility of applying your system to their Plants, and I have but the one answer, "You cannot afford to be without it."

Very truly yours,

(Signed) Henry A. Janvier,
Director and Assistant Engineer,
Ferracute Mach. Co.

Bridgeton, N. J., U. S. A.,
December 28, 1917.

My Dear Mr. Parkhurst:

I have just returned from a trip through several large manufacturing plants (where Scientific Management has not been installed) and was surprised at the chaotic condition existing, especially where an attempt was made to utilize the full capacity of the plants. One of the Superintendents said: "It would be impossible for us to use Scientific Management because we have such a great variety of work." This remark is just what was thought when you first started your system at the Ferracute, because we manufacture over fifteen hundred different types and sizes of Presses, covering thousands of parts, but the fact is, the plant that has the most variety of work, and therefore the most trouble, is in the most need of Scientific Management.

It is most gratifying that we are able to produce at least from 50% to 75% more work in our shops than we could have hoped to produce

under the conditions before Scientific Management was applied. We do not have any trouble in meeting (or anticipating, in a large number of cases) the deliveries of Presses, etc., made in our plant, and although we have been using "forced draught" throughout the entire plant for the past year (owing to the peculiar business conditions existing throughout the country) we are maintaining our usual high efficiency on deliveries of from 100% to 103%. Of course, this has been possible only through the careful planning and proper scheduling of work, with bonus, etc., as applied by your excellent methods, with the result that all Departments are very well balanced, work coming through as scheduled, and shipments made as promised, and there is entirely absent the usual worry, congestion, wasted energy and guess-work that does and must exist where Scientific Management has not been applied.

In regard to the Bonus work, we have just recently had a number of large frames to machine that used to average from thirty-five to forty hours apiece. But they are now being machined (under the same conditions except Bonus and Instructions) in sixteen to eighteen hours apiece. This is a typical job and is a good illustration of the usual reduction in time. The operator in the above job makes a Bonus equal to 25% to 30% of his wages, and would complain very much if the job were transferred to another man.

I consider it extremely fortunate that we have your system to work under, as it would be a calamity to have to go stumbling along like so many of the plants that I have recently visited.

With best wishes for the continued success you are enjoying, I remain,

Very truly yours,

(Signed) PHILIP M. MEYERS,
Superintendent,
FERRACUTE MACHINE COMPANY.

Mr. Oberlin Smith, President of the Ferracute Machine Co., stated to the author some months ago that he considered such methods as had been installed at his plant as much a capital investment item as buildings, machinery, etc., and that if it were given a value, he should consider it worth at least $100,000. The lasting results herein described can, and are, being obtained elsewhere.

As time goes on the difficulties of constructing the scientific method from the old type of management, with few or no correct records, will become less because of more common knowledge, better trained men, and a spirit of greater coöperation throughout the organization before

FIG. 49.—Reproduction of the Ferracute Machine Co. letterhead of the last few years. See Fig. 50 for detail record of efficiency referred to.

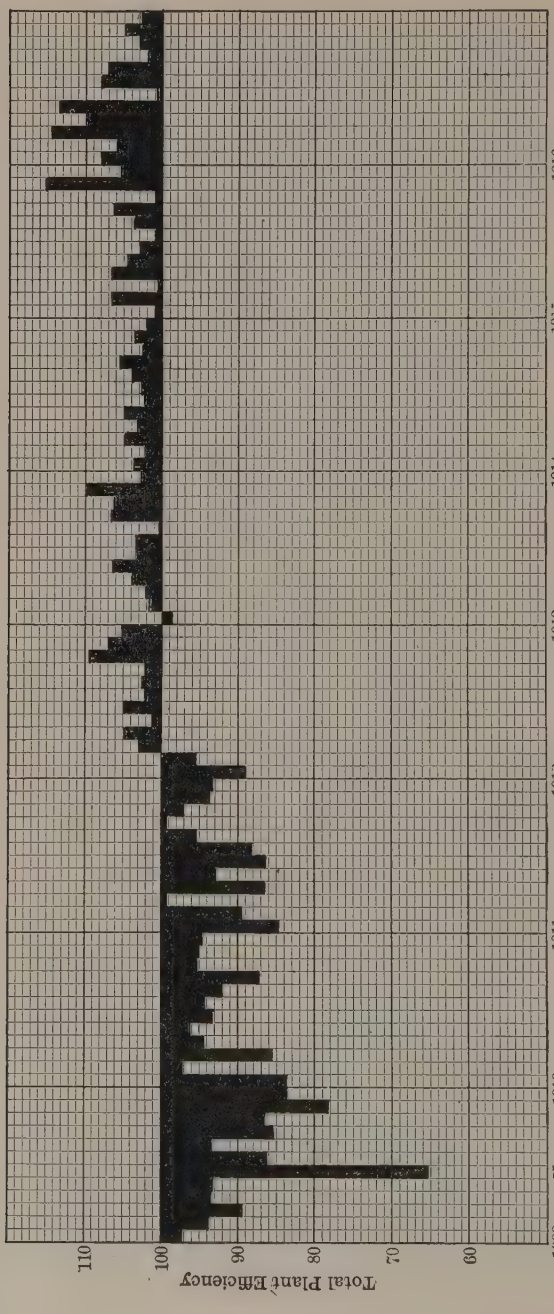


FIG. 50.—Graphical record of the entire plant efficiency as to planning, promises, deliveries and control of manufacture for a period of *eight* years. Almost a "perfect score," for the last *five* years. See reproduction of letterhead, Fig. 49.

and during the work of installing the new methods. Such conditions did not exist ten years ago.

The men who wrote the letters reproduced above represent the only firm of its kind able to maintain such a record and with sufficient courage to advertise their record. They not only did this several years ago and continue to do so, but they have held their record without a break during all of the excessive production of the war period. The record so established and maintained has received generous rec-

AS A TOKEN of our appreciation of the loyal service you have rendered, and desiring to have you share in the profits resulting therefrom, we hand you herewith five per cent. of the amount paid you during the last six months.

Cordially,

FERRACUTE MACHINE CO.

Bridgeton, N. J., July 23, 1915.

5% of $ -- $

FIG. 51.—Special bonus notice of July 23d, 1915.

ognition from customers and competitive firms throughout the country and in foreign countries as well.

Fig. 49 is a reproduction of the letterhead in use the last few years. Fig. 50 is a chart showing the entire plant efficiency as to planning, promises, deliveries and control of manufacture. This record covers *every order* shipped each month. The author believes that the reader will agree with him that such a record speaks for itself.

Last, but not least, must be recorded the existing relations between the workmen and the company. Such relations are of the first importance from the author's standpoint. The old employees, with but few exceptions,

BRIDGETON, N. J., Dec. 23rd, 1915

Mr. _____ Clock Card No. _____

On Sept. 13th, 1915, a notice was posted in our Shops announcing a *Wage Premium of 7 Per Cent.* on all Wages paid you for three months ending Oct. 2nd. At the same time the hope was expressed that we might pay another Premium upon Wages paid you for the three months ending with the year. Conditions are such that we are enabled to realize this pleasure, and we enclose herewith a *Wage Premium of 10 Per Cent.* upon Wages paid from Oct. 4th to Dec. 31, 1915, inclusive (The last two weeks being calculated at full time) as per statement below.

We wish you a very Merry Christmas and a Happy and Prosperous New Year.

FERRACUTE MACHINE CO.

10% Premium on $ ¦ $

FIG. 52.—Special bonus notice of Dec. 23d, 1915. A 7% special bonus was paid Oct. 2, 1915.

BRIDGETON, N. J., April 7th, 1916

Mr. _____ Clock Card No. _____

We are pleased to announce that the character of our work has been such during the past three months that we are enabled to continue the payment of Wage Premiums, inaugurated last year, for this period.

We enclose herewith the amount of 10% upon Wages paid you for services from January 1st to April 1st, 1916, inclusive.

FERRACUTE MACHINE CO.

10% Premium on $_____ = $_____

FIG. 53.—Special bonus notice of April 7th, 1916.

BRIDGETON, N. J., October 6th, 1916.

Mr._____ Clock Card No._____

We are pleased to announce that the character of our work has been such during the past three months that we are enabled to continue the payment of Wage Premiums, inaugurated last year, for this period.

We enclose herewith the amount of 10% upon Wages paid you for services from July 2nd to September 30th, 1916, inclusive.

FERRACUTE MACHINE CO.

10% Premium on $_____ == $_____

FIG. 54.—Special bonus notice of Oct. 6th, 1916. A similar bonus was paid for the second quarter of 1916.

BRIDGETON, N. J., Dec. 22, 1916

Mr. _____ Clock Card No._____

Our Company is nearing the close of another successful year, which enables us to give you on December 22 a *Christmas Gift* consisting of five per cent. of the amount paid you from October 1st to December 23, and additionally on December 29, a wage premium of ten per cent. of the amount paid you for the last three months of the year, (the last week being calculated at full time,) as per statement below.

We wish you a very Merry Christmas and a Happy New Year.

FERRACUTE MACHINE CO.

5% Gift on - $_____ = $_____

10% Premium on $_____ = $_____

FIG. 55.—Special bonus and Christmas Gift notice issued Dec. 22d, 1916.

are at work at their old jobs, or have been advanced to better ones. The several that have left have gone to take higher positions in other plants. The majority of the old employees frankly admit their preference for the existing methods as compared to the former. They consider themselves better men, better mechanics and in an advanced and happier condition in every way than formerly. This statement, particularly, the author will be glad to have the reader check up by a personal visit to Bridgeton, N. J.

As for the company's attitude toward the men, the following will perhaps be the best answer. Early in 1915 the officials considered adopting a profit-sharing schedule. The author's opinion was asked for and for various reasons he advised against profit-sharing, but recommended in a report to the Company under date of May 11, 1915, the adoption of a scheme of special bonus. After due consideration, his recommendation was adopted and first put into effect July 23, 1915. These special bonuses have been paid every quarter for the last two years. Figs. 51 to 55 inclusive, show reproductions of several of the notices put in each employee's envelope each time the special bonus was paid. These notices offer in themselves sufficient explanation as to the Company's policy, and fully express the Company's feeling for its employees, in a manner which the employees can and do most appreciate.

INDEX

PAGE

Analysis of time study and creation of instruction cards 157
Attitude of the workmen 331
Author's method of computing differential bonus 175

Blue-prints 36
Board meetings, factory 42
Bonus, author's differential 175
Bonus chart 208 176
Bonus times compared to day work times 122

Chart, organization 8
Chief clerk, duties of 25
Clearances, table of 33
Closure 195
Combined cost and route sheet 110
Comparison of times under day and bonus methods 122
Correspondence 13
Cost clerk 50
Cost comparison 186
Cost and route sheet combined 110
Cost sheet, schedule 110
Counting room 13
Course of an order 181
Creation of instruction card, analysis of time study and 157
Creation of a stores department 92

Day and bonus methods, comparison of times under 122
Day work 171
Decimal stop watch 147
Department symbols 75
Designs 28
Development of a manufacturing system 132
Drafting room 29
Drawings 29
Drawings, sizes of 31
Duties of chief clerk 25

PAGE
Duties of the inspector 59
Duties of secretary-treasurer per the by-laws 13

Engineering room 27
Engineer, shop 48
Erection work, handling of 135
Estimates 28
Experiments 28

Factory board meetings 42
Factory mail system 56
Foremen's meetings 41
Form of organization 8
Functions of planning department 43

Gang bosses 85
Gantt bonus 174
General route sheet 83

Handling of erection work 135
Horse-power meter 156
How much to sell 22
How to sell 23

Immediate relief 6
Information 29
Inspector 59
Instructions, Appendix ..... 199 to 320
Anticipating requirements, XIV 243
Apprentices, grade of, V 211
Care and inventory of scrap metals, XIX 253
Chief clerk, IX 226
Cost clerk, XX 256
Crane boss, XXXIV 304
Decimal system of time keeping, XXII 267
Die engineers, VI 211
Drafting room, VII 215
Drawing boys, XXXI 296
Drawing and sketch indexes, VIII 223
Factory mail system, XXV 279
Follow up methods, XV 246
Forms, description of, XXXIX 314
General orders, XXXV 306
Inspector, XXVI 281
Janitor, XXXIII 301
Manufacturing numbers, XIII 242
Movement of batches in installments, XVI 249

Instructions, Appendix—*Continued.* PAGE
Night watchman, XXXII ... 299
Order-of-work clerk, XV ... 246
Organization record, I ... 199
Parts returned, XXXVI ... 310
Patterns and casting purchase orders, XXXVIII ... 313
Planning department, X ... 231
Planning department monthly report, XI ... 233
Production clerk, X ... 231
Purchase orders, XXXVII ... 311
Route rack signals, XVII ... 249
Schedule clerk, XXIX ... 270
Shop rules, Ferracute Machine Co., IV ... 206
Stores clerk, XVIII ... 250
Stores keeper, XXVII ... 285
Superintendent, III ... 202
Symbol groups, XII ... 240
Time clock, XXIII ... 268
Time keeper, XXI ... 263
Tools, care and storage of, XXX ... 295
Tool foreman, XXVIII ... 287
Tool requirements, XXIX ... 298
Vice president and assistant manager, II ... 200
Instruction card ... 157
Introduction of time studies ... 147
Investigation, preliminary ... 4

Machine symbol letters ... 77
Manufacturing system, development of ... 132
Material boss ... 78
Material lists ... 36
Meetings, factory board ... 42
Meetings, foremen's ... 41
Methods and tools, Standardization of ... 115
Move material boss ... 62

New work, supervision of ... 28

Operation symbols ... 76
Order-of-work clerk ... 52, 80
Organization chart ... 8
Organization, form of ... 8
Organization record ... 11

Parkhurst differential bonus ... 174
Permanent results obtained ... 324
Perpetual inventory ... 98
Photographs ... 36

PAGE
Piece work ... 171
Planning department ... 37
Planning department, specific advantages of ... 37
Policy ... 332
Preliminary investigation ... 4
Premium work ... 171
Production clerk ... 47
Prophecy, A ... 321
Publicity engineer ... 27
Purchases ... 13

Receiving clerk ... 53
Record, organization ... 11
Registering of time consumption ... 105
Relief, immediate ... 6
Remuneration, different systems of ... 166
Results obtained by scientific management ... 186
Route clerk ... 50
Routing of work ... 64
Route rack signals ... 82
Route sheet, combined cost and ... 110
Route sheet, general ... 83

Sales department ... 17
Sales manager ... 16
Schedule clerk ... 55
Schedule cost sheet ... 110
Secretary-treasurer ... 13
Shipping clerk ... 53
Shop engineer ... 48
Six years after ... 321
Sketches ... 29
Slide rules ... 155
Speed boss ... 87
Standards ... 36
Standardization of methods and tools ... 115
Stop watch, decimal ... 147
Stop watch, use of ... 147
Stores clerk ... 49
Stores department, creation of ... 92
Stores keeper ... 61
Stores ledger ... 98
Symbol groups ... 240
Symbols ... 70
Symbols department ... 75
Symbols, operation ... 76

PAGE
Superintendent's duties 40
Supervision of new work 28

Taylor differential piece rate 174
Time boy 58
Time clerk 54
Time consumption, registering of 105
Time study 147
Time study, analysis of 157
Time studies, introduction of 147
Tolerances, table of 33
Tracings 36

What to sell 21
World wide knowledge of scientific management in 1917 321

THE UNIVERSITY OF MICHIGAN

BUSINESS ADMINISTRATION
LIBRARY

DATE DUE

JAN 13 1995
7 1984
FEB 01 1995
JAN 14 1995

RECEIVED
DEC 17 1984
THE UNIVERSITY OF MICHIGAN
GRADUATE LIBRARY

T55.9.P24 1917 c.1 STA
Parkhurst, Frederic Augustus
Applied methods of scientific management
3 5128 00033 2385
U of Michigan. Kresge Bus Admin Library